	Exhibit R-2, RDT&E	DATE Februar	y 2005			
BUD 03 /	GET ACTIVITY Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603401F Advanced Space	PE NUMBER AND TITLE 0603401F Advanced Spacecraft Technology			
(U)	B. Program Change Summary (\$ in Millions)					
		<u>FY 2004</u>	<u>FY 2005</u>	<u>FY 2006</u>	<u>FY 2007</u>	
(U)	Previous President's Budget	96.912	60.124	65.892	72.085	
(U)	Current PBR/President's Budget	105.557	89.839	60.915	67.221	
(U)	Total Adjustments	8.645	29.715			
(U)	Congressional Program Reductions		-0.087			
	Congressional Rescissions		-0.798			
	Congressional Increases		30.600			
	Reprogrammings	9.415				
	SBIR/STTR Transfer	-0.770				
(U)	Significant Program Changes:					
	Not Applicable.					
	C. Performance Metrics					
	(II) Under Development					
	(c) ender Development.					
1						
1						
1						
1		R-1 Shopping List - Item No. 26-2 of 26-28		Exhibit R-	2 (PE 0603401F)	

	E	Exhibit R-2	a, RDT&E	Project J	ustificatio	on			DATE	February 2	2005
BUDG 03 A	ET ACTIVITY dvanced Technology Developmei	nt (ATD)			PE NUMBER AND TITLE PRO 0603401F Advanced Spacecraft 218 Technology			DJECT NUMBER AND TITLE 31 Spacecraft Payloads			
	Cost (\$ in Millions)	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	Cost to	Total
		Actual	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Complete	
2181	Spacecraft Payloads	32.515	26.787	18.966	18.891	25.562	28.339	30.106	30.663	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		
	This project funds the development, der advanced satellite surveillance operatio systems. Improved space-qualifiable el near-term, this project's work concentra systems. For mid-term applications, the technologies with commercially-derived Defense satellites. In the long-term, this constellations of intelligent satellites ca	monstration, a ns, and develo lectronics and ates on conver e Improved Sp d, open systen is project area pable of perfo	nd evaluation opment of adv. software for c ting (i.e., radia bace Compute n architectures focuses on de rming all miss	of radiation-h anced laser co lata and signal ation-hardenin r Program will s to develop ar veloping low- sion related fu	ardened space mmunications processing w g) commercia l merge advan nd demonstrate cost, easily m nctions witho	e electronic has s technologies vill be more int l data and sign aced, radiation- e robust, on-be odifiable softw ut operator int	rdware, satelli to support ne- terchangeable hal processor to hardened spa- bard processir ware and hard ervention.	ite control har xt generation , interoperable technologies f ace processor, ng capabilities ware architect	dware and so satellite comr e, and standar for use in Air memory, and for 21st cent tures for fully	ftware for nunications dized. In the Force space interconnect ury Departmen autonomous	nt of
(U) (U)	B. Accomplishments/Planned Progra MAJOR THRUST: Develop spacecraf processors and ultra-high density strate advanced packaging technology, and m applications.	um (\$ in Million ft microelectro gically harder nicro-electro-n	o <u>ns)</u> nic devices, in ned memories, nechanical sys	ncluding radia space-qualifia stems (MEMS	tion-hardened able, high den) components	data sity and	<u>FY 200</u> 8.73	<u>04 FY</u> 33	<u>2005</u> 9.744	<u>FY 2006</u> 9.507	<u>FY 2007</u> 10.822
(U) (U)	In FY 2004: Demonstrated functional per second and digital signal processor and designed electronics circuits in sup Demonstrated functional elements of cl microelectronics. Developed hardened state-of-the-art commercial manufactur electronics. Built MEMS and chalcoge smart-wiring manifolds. Designed the miniaturized military global positioning In FY 2005: Initiate the development of second and digital signal processors at circuits in support of adaptable, self-rep	elements for g s at one millio port of adapta halcogenide-b l-by-design pri- ring plants for enide-based sw functional har g system recei of a general-pu one million op pairing proces	eneral-purpos n operations p ble, self-repai ased field pro- mitive cell lib high performa- vitches suppor dened by desi ver. urpose process perations per s sors and mem	e processor at per second. De ring processor grammable log praries enablin ance, low-cost ting multi-swi gn and archite sor at 500 mill second. Demo ories enabling	500 million i eveloped arch rs and memori gic and analog g the use of digital and m itch box applie ecture element ion instruction onstrate electro g spacecraft ca	nstructions itectures ies. g ixed signal cations to s of the ns per onics pable of					
Desi	autonomously adapting to new mission programmable logic and analog microe enabling the use of state-of-the-art com	s. Build funct electronics. Do nmercial manu	tional element evelop harden facturing plan	s of chalcoger ed by design r its for high per	nide-based fiel nacrocell libra rformance, lov	ld aries v-cost					
Proje	901 2 1 8 1			K-I Snopping Li	<u>151 - Item No. 26</u> 459	-3 01 26-28				Exnidit R-2a (P	′E 0603401F)

Exhibit R-2a, RDT&E Project Just	DATE February 2005				
BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603401F Advanced Spa Technology	cecraft	PROJECT NUME 2181 Spacec	BER AND TITLE	
 electronics. Demonstrate elements for hieratical smart-wiring manifolds capable of r space asset subsystems. Implement the hardened-by-design mixed signal library and analog-to-digital converter demonstration; fabricate devices in the Silicon Germanium performance and environmental ruggedness of the miniaturized military global positi receiver through initial logic block engineering model. (U) In FY 2006: Develop and validate the building blocks for a general-purpose processes instructions per second and digital signal processors at one million operations per second set of design tools for integrating hardening by design into commercial design tools. megabyte chalcogenide-based nonvolatile memory. Fabricate the first design harden application specific integrated circuit (ASIC) to implement increased ASIC performate devices. Design and fabricate the initial test vehicle to demonstrate the miniaturized 	econfiguring entire the design for n process. Validate oning system (GPS) or at 500 million ond. Provide the Fabricate a 16 ed structured nce on low cost military GPS				
 receiver performance on low-cost devices. (U) In FY 2007: Complete engineering model of the high performance 500 million instrugeneral-purpose processor. Fabricate a high performance design hardened analog-to (ADC) for use in space and fabricate a very low-power ADC using advanced design hardening. Fabricate the miniaturized military GPS receiver for use on terrestrial, ae platforms. Fabricate the building blocks for a very high performance ten million-gat field programmable gate array. 	action per second digital converter cells and design ro, and space e design hardened				
 (U) (U) MAJOR THRUST: Develop intelligent satellite system technologies for responsive and for satellite control, precision navigation, formation flying, and proximity operat anagoraft constallations. 	spacecraft operations ions technologies for	2.803	2.783	2.607	2.685
 (U) In FY 2004: Expanded the development of command, control, and navigational capa fidelity spacecraft proximity operations with application to counterspace operations. development of automated planning and scheduling software for multiple satellites at and simulation data archiving and storage system. Expanded development of guidan control algorithms for proximity operations and large deployable systems. Develope and telemetry simulation for mission operations center testing. Enhanced development software technologies for responsive space systems. 	bility for high Completed nd the spacecraft ce, navigation, and d initial command nt of autonomous				
(U) In FY 2005: Advance development of command, control, and navigational capability spacecraft proximity operations with application to counterspace operations. Comple guidance, navigation, and control algorithms for proximity operations and large deple Further command and telemetry simulation development for mission ops center testin hardware-in-the-loop engineering development unit into testbed, interface with space	y for high fidelity ete development of oyable systems. ng. Integrate craft command and				
Project 2181 R-1 Shopping List - I	em No. 26-4 of 26-28			Exhibit R-2a (PE	0603401F)

	Exhibit R-2a, RDT&E Project Justification						
BUDGET ACTIVITY 03 Advanced Technolc	ogy Development (ATD)	PE NUMBER AND TITLE 0603401F Advanced S Technology	PE NUMBER AND TITLE 0603401F Advanced Spacecraft Technology				
telemetry simulations for responsive space level, mission/engage unique distributed ap tools.	s, and begin mission ops center testing. Refine autonomic systems. Design integrated distributed aperture sensor ement and campaign level analyses, identifying module erture sensor features to be incorporated into existing a	mous software technologies analysis tool for engineering es required for implementing modeling and simulation					
(U) In FY 2006: Validat algorithms for proxir and navigational caps offensive/defensive of ops center testing. C testbed, interface wit testing. Build unique mission/engagement	e command and control capabilities and guidance, navi nity operations with flight experiment data. Refine con abilities for counterspace to apply to space situational a operations. Complete command and telemetry simulation omplete integration of hardware-in-the-loop engineering h spacecraft command and telemetry simulations, and e distributed aperture sensor simulation modules for en and campaign level analysis tool.	igation, and control mmand, control, guidance, awareness and ion development for mission ng development unit into conduct mission ops center gineering level,					
(U) In FY 2007: Continu counterspace to apply integrate autonomous technologies to support command and telemed and tactical space system engineering level, maging	te to refine command, control, guidance, and navigatio y to space situational awareness and offensive/defensives s flight software technologies with command, control, port responsive space systems. Extend hardware-in-the- etry simulations, and mission ops center to development stems. Integrate modules and complete distributed ape ssion/engagement and campaign level analyses.	anal capabilities for ve operations. Begin to guidance, and navigation -loop testbed, spacecraft at and testing of responsive orture sensor analysis tool for					
 (U) (U) MAJOR THRUST: 1 methodologies for sp access/mobility techn Force priorities. 	Develop modeling, simulation, and analysis tools and on ace-based surveillance systems, space capability protection ologies, and flight experiments. Note: In FY 2006, respectively.	data exploitation ction technologies, eduction due to higher Air	0.965	0.923	0.692	1.199	
(U) In FY 2004: Refined Further developed m surveillance systems tools for technical as Developed first gene engineering, tech trad flight experiments.	I models for radio frequency (RF) system simulation to odels of RF signal processing. Refined simulation models for military utility analysis. Developed initial modeling sessment of space capability protection and access/moder ration of physics-to-engineering-to-engagement level r des, mission planning and operations, and utility analys	o support systems engineering. dels of space-based ng, simulation, and analysis bility technologies. nodels for systems sis applicable to potential					
(U) In FY 2005: Complete signal processing mc	ete development of models for RF system simulation. (dels. Expand development of simulations of space-based and the space-bas	Complete development of RF sed surveillance systems for					
Project 2181	R-1 Shopp	bing List - Item No. 26-5 of 26-28			Exhibit R-2a (PE	E 0603401F)	

Exhibit R-2a, RDT&E Project Jus		DATE February 2005		
BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603401F Advanced Spacecraft Technology	PROJEC 2181 S	T NUMBER AND TITLE pacecraft Payloads	
military utility analysis. Refine development of modeling, simulation, and analysis assessment of space capability protection and access/mobility technologies. Continu physics-to-engineering-to-engagement level models for systems engineering, tech tr planning and operations, and utility analysis applicable to potential flight experimen	tools for technical ne to develop ades, mission ts.			
(U) In FY 2006: Further expand development of models of surveillance systems for mil tactical surveillance and electro-optical technologies. Initiate model development of reconfigurable technologies. Refine development of physics-to-engineering-to-enga for systems engineering, tech trades, mission planning and operations, and utility an experiments in tactical and responsive satellites.	itary utility to include responsive and gement level models alysis for flight			
(U) In FY 2007: Complete development of models of surveillance systems for military tactical surveillance and electro-optical technologies. Continue to develop models or reconfigurable technologies. Apply physics-to-engineering-to-engagement level models engineering, tech trades, mission planning and operations, and utility analysis to flig tactical and responsive satellites.	utility to include f responsive and dels for systems ht experiments in			
(U) (U) MAIOP THRUST: Develop advanced space infrared technology and hardened feet	l plana datactor 2 257	2.20	6 2 175	2 638
arrays to enable acquisition, tracking, and discrimination of hot targets, as well as "c such as decoys, satellites, and midcourse warheads.	old body" targets	2.20	.0 2.175	2.038
(U) In FY 2004: Characterized higher operating temperature, mid-wave infrared focal p Completed fabrication and characterization of higher operating temperature, mid-wa Completed fabrication and characterization of first-ever dual band (mid-wave, long- an extended long-wave infrared response. Investigated radiation hardened-by-desig development for long wavelength infrared FPAs for space-based passive surveillanc Explored detector interfacing concepts for larger-format higher capability space by	lane arrays (FPA). ve infrared FPAs. wave) FPAs having n (RHBD) e applications. perspectral imaging			
systems.	1			
(U) In FY 2005: Complete pathfinder, dual-band (mid-wave, long-wave) FPA performa and transition plan for insertion into a potential hyperspectral demonstration. Invest and cryogenic detector multiplexer interfacing concepts that lead to improved, larger hyperspectral imaging capabilities. Extend performance of single and dual color FP background levels to more stressing lower background levels needed for operation i	nce characterization igate detector array -format, space As from moderate a space sensing.			
(U) In FY 2006: Initiate assessment of large format Read Out Integrated Circuits, design and fabricated on existing foundries. Investigate the readout and greater focal plane	ned through RHBD,			
enhancements needed for emerging detector array technologies.	array portormance			
(U) In FY 2007: Initiate studies for detectors and readouts needed for laser-based survei	llance. Continue			
Project 2181 R-1 Shopping List -	tem No. 26-6 of 26-28		Exhibit R-2a (PE	0603401F)

	Exhibit R-2a, RDT&E Project Ju	DATE February 2005				
BUD 03 /	GET ACTIVITY Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603401F Advanced Technology	d Spacecraft	PROJECT NUME 2181 Spacec	BER AND TITLE raft Payloads	
	investigation into readouts fabricated on existing foundries and radiation hard desi	gn principles.				
(U) (U)	MAJOR THRUST: Develop and demonstrate satellite antenna technologies that e electronic integration, high-density interconnects/packaging and advanced phased technologies to create large, lightweight space antennas. Note: This work was ter FY 2004 due to higher priorities.	xploit advanced array component minated at the end of	1.430	0.000	0.000	0.000
(U)	In FY 2004: Delivered flight-ready multi-beam, wide-bandwidth antenna modules multi-mode flight experiment. Redesigned baseline antenna module tiles using ad material to reduce antenna module weight by 25%. Developed and demonstrated to low power, octave-wide bandwidth, low noise amplifier. Applied Application Spet technology to achieve a higher level of integration for the transmit-receive cells, recomponents by 25%. Redesigned antenna tile architecture to incorporate next gen phased array components to support eight simultaneous beams. Designed multi-de antenna architecture.	o for airborne vanced substrate en milliwatt advanced cific Integrated Circuit ducing discrete eration miniaturized ecade-bandwidth				
(U)	In FY 2005: Not Applicable.					
(U)	In FY 2006: Not Applicable.					
(U)	In FY 2007: Not Applicable.					
(U) (U)	MAJOR THRUST: Develop technologies for multi-access laser communications reduced weight, power, and cost for transformational communications. Note: In F increased emphasis on laser communications space terminal development.	space terminals with Y 2004, there was an	10.709	1.846	2.124	1.334
(U)	In FY 2004: Investigated component integration issues and identified technical ch space experiments of multi-access laser communications systems. Developed initi testbed. Completed space-based laser communications architecture studies.	allenges for potential al ground breadboard				
(U)	In FY 2005: Explore component integration issues of multi-access laser communi Complete ground breadboard testbed. Test breadboard terminal designs in approve testbed. Develop initial multi-access laser communications terminal brassboard de	cations systems. ed compatibility evelopment.				
(U)	In FY 2006: Start development of components toward space-qualification and bra Continue development of multi-access laser communications terminal brassboard. components/system in relevant environmental.	ssboard integration. Start testing of				
(U)	In FY 2007: Finalize brassboard integration. Begin identification and design of su	iitable space				
	experiments. Begin development and qualification testing of flight hardware.					
(U)	MAIOD THDUCT. Develop actallity and had a base of the local of the life	····· 1·····	1.000	0.000	0.000	0.000
(U)	MAJOK THRUST: Develop satellite payload subsystem technologies to exhibit re	evolutionary	1.982	0.000	0.000	0.000
Pro	Ject 2181 R-1 Shopping List		Exhibit R-2a (P	E 0603401F)		

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	Exhibit R-2a, RDT&E Project Just	ification		DATE February 2005			
BUD 03 /	GET ACTIVITY Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603401F Advanced Technology	PROJECT NUMBER AND TITLE 2181 Spacecraft Payloads				
	capabilities in operability, responsiveness, and cost-effectiveness. Note: In FY 2005,	, this effort has been					
(U)	In FY 2004: Developed enabling responsive spacecraft technologies, which include of programmable, configurable, logic, and modular, reusable, self-initiating software, as technologies that enable rapid satellite integration and minimum time on-orbit satellit	on-the-fly well as e checkout.					
(U)	In FY 2005: Not Applicable.						
(U)	In FY 2006: Not Applicable.						
(U) (U)	In FY 2007: Not Applicable.						
(U)	MAJOR THRUST: Develop spectral/polarimetric sensing and data exploitation demo military imaging and remote sensing applications. Note: In FY 2005, advanced effor 0602601F, Space Technology.	nstrations for ts from PE	0.000	0.185	1.861	0.213	
(U)	In FY 2004: Not Applicable.						
(U)	In FY 2005: Develop concepts for electro-optical/infrared spectral polarimetric space Examine hardware issues and begin technology development plan. Begin developme FPA technology.	e demonstrations. nt of polarimetric					
(U)	In FY 2006: Complete polarimetric FPA test article and validate performance. Integr laboratory camera and collect high quality data in the laboratory of relevant materials	rate FPA into					
(U)	In FY 2007: Conduct field collection with polarimetric focal plane camera. Demonst hardware design for transition to acquisition system.	trate feasibility of					
(U)							
(U) (U)	CONGRESSIONAL ADD: Alternating Current (AC) Coupled Interconnect. In FY 2004: Using previously established and proven principles, provided a system le of a non-conductive interconnection technology, in a form suitable for transfer to indu electronic system that demonstrates all the advantages of non-conductive interconnect realistic environment for one form of packaging.	evel demonstration astry. Built an tion technology in a	1.172	0.991	0.000	0.000	
(U)	In FY 2005: Demonstrate the ability of an AC-coupled interconnect approach to be u two different parts of a complex system (i.e., third-level packaging.) Under this assur design of the interconnect to maximize signal transport efficiency and minimize the b misalignment and multiple mating cycles.	sed in connecting nption, optimize the it error rate due to					
(U)	In FY 2006: Not Applicable.						
(U)	In FY 2007: Not Applicable.						
(U)	CONCRESSIONAL ADD: Magnetoresistive Pandom Access Momory (MPAM) In	ovativa	1 464	1 180	0.000	0.000	
	constant and, magnetoresistive Kalidolli Access Melliory (MRAM) III	$\sum_{n=1}^{\infty} \sum_{i=1}^{\infty} \sum_{j=1}^{\infty} \sum_{i=1}^{\infty} \sum_{i$	1.404	1.107			
Pro	R-1 Shopping List - Ite	-π πο. 20-0 οι 20-20 SΔ			Exhibit K-2a (Pl	L 0003401F)	

Exhibit R-2a, RDT&E Project Ju	Exhibit R-2a, RDT&E Project Justification						
BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603401F Advanced Spa Technology	PE NUMBER AND TITLE 0603401F Advanced Spacecraft Technology					
 Communications Materials. (U) In FY 2004: Developed and characterized a magnetic tunneling junction magnetic 0.25 micron in size, along with supporting circuitry and architecture models, leadin radiation-hard, non-volatile memory for embedded and reconfigurable spacecraft c (U) In FY 2005: Integrate MRAM cells, which are intrinsically radiation-hard, with R leading to embedded memories for spacecraft systems that are more immune to sin from high energy particles. Support an unlimited number of read-write cycles with access time, while consuming less than a nonowatt per bit. (U) In FY 2006: Not Applicable. (U) In FY 2007: Not Applicable. 	memory element 1 by ng to distributed, computing systems. HBD microelectronics, ngle event upset effects n ten nanoseconds						
 (U) CONGRESSIONAL ADD: Advanced Life Cycle Cost (LCC)/Risk Model for Space Development. (U) In FY 2004: Not Applicable. (U) In FY 2005: Incorporate Space concept cost modeling processes and methodologic modeling and simulation code, the Advanced LCC/Risk Estimating Tool, which w incorporated into an existing modeling and simulation tool to provide integrated de LCC/risk estimating. (U) In FY 2004: Not Applicable. (U) In FY 2007. Not Applicable. 	ace Concept es into a software ill then be esign, analysis, and	0.000	0.991	0.000	0.000		
 (U) In FY 2007: Not Applicable. (U) (U) CONGRESSIONAL ADD: Systematic Hierarchical Approach to Radiation Harde (U) In FY 2004: Not Applicable. (U) In FY 2005: Develop RHBD process design kits (PDKs). PDKs are targeted at co integrated circuit (IC) fabrication processes. Verify proper operation of PDKs aga generated for DoD space applications such as GPS receiver ICs. Fabricate and cha response of RHBD IC test chips and validate radiation characterization data versus Provide standardized PDKs for the design phase of radiation hardened ICs. Provid for qualified, automated generation of hardened ICs during production phase. (U) In FY 2006: Not Applicable. (U) In FY 2007: Not Applicable. 	ened Electronics. ommercial, on-shore ainst RHBD ICs aracterize radiation a simulated results. le accelerated potential	0.000	1.487	0.000	0.000		
 (U) (U) CONGRESSIONAL ADD: Radiation Hardening Microelectronics. (U) In FY 2004: Not Applicable. 		0.000	1.388	0.000	0.000		
Project 2181 R-1 Shopping List	- Item No. 26-9 of 26-28			Exhibit R-2a (PI	E 0603401F)		

		Exhibit R-2a, RDT&E Project Justification									DATE February 2005			
BUD 03 /	GET ACTIVITY Advanced Technology Deve	lopment (ATI))		PE N 0603 Tec	PE NUMBER AND TITLE PRC 0603401F Advanced Spacecraft 218 Technology				R AND TITLE I ft Payloads				
(U) (U) (U)	In FY 2005: Develop and dem applications using both design electronics design can be rapidl improved hardened fabrication both natural and man-made rad In FY 2006: Not Applicable. In FY 2007: Not Applicable.	onstrate next-ge and process har ly transitioned t industrial infra- liation. Demons	eneration electr dening techniq o DoD space a structure and b strate sizes as h	ronics technolo ues. Show that pplications by y modifying the ow as 0.15 mic	gy for DoD spa t an emerging o taking advanta; e design to han rons.	ace systems commercial ge of the den against								
(U) (U) (U) (U)	CONGRESSIONAL ADDS: 1 Space Optical Satellite Commu In FY 2004: Not Applicable. In FY 2005: Develop engineer high spaced multi channel gim	Intelligence Fre inications Node ing model intra	e Space Optica	al Communicati	ions and Intelli cations networ	gent Free k components,	0.	000	2.974	0.000	0.000			
(U) (U) (U)	intelligent/adaptive intra-satelli testing. In FY 2006: Not Applicable. In FY 2007: Not Applicable. Total Cost	ite switching an	d routing comp	ponents with in	itial space pre-	qualification	32.	515	26.787	18.966	18.891			
(U)	C. Other Program Funding St	ummary (\$ in I	<u>Millions)</u>											
(U) (U) (U) (U) (U)	Related Activities: PE 0303601F, MILSTAR Satellite Communications System. PE 0305160F, Defense Meteorological Satellite Program (DMSP). PE 0602601F, Spacecraft Technology. PE 0603311F, Ballistic Missile Technology. PE 0603215C, Limited	<u>FY 2004</u> <u>Actual</u>	<u>FY 2005</u> <u>Estimate</u>	<u>FY 2006</u> <u>Estimate</u>	<u>FY 2007</u> <u>Estimate</u>	<u>FY 2008</u> <u>Estimate</u>	<u>FY 2009</u> <u>Estimate</u>	<u>FY 2010</u> Estimate	<u>FY 2011</u> Estimate	<u>Cost to</u> <u>Complete</u>	<u>Total Cos</u> t			
Pro	oject 2181			R-1 Shoppi	ng List - Item No	26-10 of 26-28				Exhibit R-2a (P	E 0603401F)			

Exhibit R-2	Exhibit R-2a, RDT&E Project Justification								
BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603401F Advanced Spacecraft Technology	PROJECT NUMBER AND TITLE 2181 Spacecraft Payloads							
 (U) <u>C. Other Program Funding Summary (\$ in Millio</u> Defense System. (U) PE 0603218C, Research and Support. PE 0603226E, Experimental (U) Evaluation of Major Innovative Technologies. PE 0604609F, Reliability and (U) Maintainability Technology Insertion Program (RAMTIP). This project has been coordinated through the (U) Reliance process to harmonize efforts and eliminate duplication. (U) <u>D. Acquisition Strategy</u> Not Applicable. 	<u>,</u>								
Project 2181	R-1 Shopping List - Item No. 26-11 of 26-28	Exhibit R-2a (PE 0603401F)							

	E	Exhibit R-2	a, RDT&E	Project J	ustificatic	on			DATE	February 2	2005
BUDG 03 A	ET ACTIVITY dvanced Technology Developme	nt (ATD)			PE NUMBER AND TITLE PRO 0603401F Advanced Spacecraft 383 Technology Der				ROJECT NUMBER AND TITLE 834 Integrated Space Technology emonstrations		
	Cost (\$ in Millions)	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	Cost to	Total
3834	Integrated Space Technology Demonstrations	30.160	23.376	21.958	26.272	29.101	32.266	35.480	36.138	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		
(U) <u> </u>	A. Mission Description and Budget In This project is a series of advanced tech Laboratory, other Government laboratory validate the technologies in an relevant	tem Justificat nology demon ories, and indus environment.	ion nstrations desi stry. These te	gned to addre chnologies are	ss mission nee e integrated in	eds by applyin to system-leve	g emerging te el demonstrati	cchnologies front on that are u	rom the Air Fo used to test, eva	orce Research aluate, and	
(U) (U)	 J) <u>B. Accomplishments/Planned Program (\$ in Millions)</u> <u>J) MAJOR THRUST: Develop microsatellite (10-100Kg) technologies for integrated, robust, flexible, 21.861</u> <u>18.420</u> <u>21.958</u> <u>26.272</u> <u>26.272</u> <u>18.420</u> <u>21.958</u> <u>26.272</u> <u>18.420</u> <u>18.420</u> <u>18.420</u> <u>21.958</u> <u>26.272</u> <u>18.420</u> <u>18.420</u> <u>18.420</u> <u>21.958</u> <u>26.272</u> <u>18.420</u> <u>18.420</u> <u>21.958</u> <u>26.272</u> <u>21.958</u> <u>26.272</u> <u>18.420</u> <u>21.958</u> <u>26.272</u> <u>21.958</u> <u>26.272</u> <u>18.420</u> <u>21.958</u> <u>26.272</u> <u>18.420</u> <u>21.958</u> <u>26.272</u> <u>21.958</u> <u>26.272</u> <u>18.420</u> <u>21.958</u> <u>26.272</u> <u>21.958</u> <u>21.958</u> <u>26.272</u> <u>21.958</u> <u>26.272</u> <u>21.958</u> <u>26.272</u> <u>21.958</u> <u>26.272</u> <u>21.958</u> <u>26.272</u> <u>21.958</u> <u>21.958</u> <u>25.274</u> <u>21.958</u> <u>21.958</u> <u>21.958</u> <u>21.958</u> <u>21.958</u> <u>21.958</u> <u>21.958</u> <										
(U)	 software simulation. Performed simulated proximity operations missions for mission operations training and for determination of the simulated spacecraft performance and interaction with ground controllers. U) In FY 2005: Complete environmental testing. Complete development of autonomous proximity operations microsatellites ground control interface system. Perform real-time hardware-in-the-loop and software-in-the-loop mission experiments and testing beyond spacecraft envelope. Complete satellite/launch vehicle integration and launch. Perform mission operations around several non-cooperative resident space objects. Evaluate options for potential follow-on space situational awareness technology demonstration using operational concept trades. Perform preliminary design 										
(U) Proje	concept trades and initial satellite desig design. Complete preliminary bus and In FY 2006: Complete autonomous fli satellite design(s). Initiate procurement bus. Develop and test ground control s	gn(s). Downse payload desig ght demonstra it of bus and pa system for real	elect to best pa n. tion. Perform ayload hardwa -time planning	yload option. de-orbit man are. Begin fab g of flight ope R-1 Shopping Lis	Initiate satell euver. Comp prication of pa trations of situ	ite bus lete yload and ational 12 of 26-28				Exhibit R-2a (P	E 0603401F)

BUDGET ACTIVITY PE NUMBER AND TITE PROJECT NUMBER AND TITE 03 Advanced Technology Development (ATD) PE0.0000 383 Integrated Space Technolog awarcness missions. Develop and test flight software. Perform simulated missions against simulated faults and anomaites. 383 Integrated Space Technolog (U) In FY 2007: Complete payload and bus fabrication. Perform functional and environmental tests of payload and bus. Complete system arel singeration of payload and microsatellite and complete functional and environmental tests of integrated system. Begin integration with launch vehicle. Integrate ground control system and sulcifite software simulations. Perform simulated mission operations for missions operations training. 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000		Exhibit R-2a, RDT&E Projec	ct Justification		DATE	DATE February 2005			
awareness missions. Develop and test flight software. Perform simulated missions against simulated failts and anomalies. (1) In FY 2007: Complete payload and bus fabrication. Perform functional and environmental tests of payload and bus. Complete system level integration of payload and microsaucific and complete functional and environmental tests of integration of payload and microsaucific and complete functional and environmental tests of integration of payload and microsaucific and complete functional and environmental tests of integration operations for missions operations training. (U) (C) CONCRESSIONAL ADD: AESIR Reusable Liquid Oxygen/Liquefied Natural Gas (LOX/LNG) Launch 2.050 0.000 0.000 0.00 (U) (C) CONCRESSIONAL ADD: AESIR Reusable Liquid Oxygen/Liquefied Natural Gas (LOX/LNG) Launch 2.050 0.000 0.000 0.00 (U) (D) Fechnology. (D) 0.000 pound, hurust LOX/LNG engine to establish the feasibility of the basic propulsion concepts. This effort could lead to a relatively high performance, reusable 30,000 pound, pump-fed, regeneratively coulded thust persure-fed design to support plume detection and discrimination test objectives. (U) 1 N = Y 2007: Not Applicable. (U) 1 N = Y 2007: Not Applicable. (U) 1 N = Y 2007: Not Applicable. 0.000 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 <th>BUD 03 /</th> <th>GET ACTIVITY Advanced Technology Development (ATD)</th> <th>PE NUMBER AND TITLE 0603401F Advanced S Technology</th> <th colspan="3">PE NUMBER AND TITLE 0603401F Advanced Spacecraft Technology</th> <th>hnology</th>	BUD 03 /	GET ACTIVITY Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603401F Advanced S Technology	PE NUMBER AND TITLE 0603401F Advanced Spacecraft Technology			hnology		
 In IPY 2007: Complete system level integrated on payload and microsatellite and complete functional and environmental tests of integrated system. Begin integration with a lunch vehicle. Integrate ground control system and satellite software simulations. Perform simulated mission operations for missions operations training. (U) (U) CONORESSIONAL ADD: AESIR Reusable Liquid Oxygen/Liquefied Natural Gas (LOX/LNG) Launch 2.050 0.000 0.000 0.00 Vehicle Technology. (U) In FY 2004: Fabricated and tested 30.000 pound thrust LOX/LNG engine to establish the feasibility of the basic propulsion concepts. This effort could lead to a relatively high performance, reusable 30.000 pound, pump-fed, regeneratively cooled chamber propulsion system and a two-stuge-to-orbit vehicle system concept; effort could also lead to a reusable, configurable-plume propulsion system and target vehicle will be a relatively simple pressure-fed design to the target vehicle will be a relatively simple pressure-fed design to support plume detection and discrimination test objectives. (U) In FY 2006: Not Applicable. (U) In FY 2007: Not Applicable. (U) In FY 2006: Tot Applicable. (U) In FY 2007: Not Applicable. (U) In FY 2007: Not Applicable. (U) In FY 2006: Expande dhe capabilities of an existing integrated engineering, modeling, simulation, and design to that supports rapid modeling and collaborative Research, Development, Test, and Evaluation of advanced spacecraft and launch vehicles. Enhanced capabilities include modeling of more complex launch vehicles. Enhanced capabilities include modeling of more complex launch vehicles. Enhanced capabilities include modeling of more complex launch vehicles. Enhanced engreted engritement for furture tarcical conventional weapons delivery. (U) In FY 2006: Expand to merspheric renerty performance for studies of future tarcical conventional weapons delivery. (awareness missions. Develop and test flight software. Perform simulated n	nissions against simulated						
(U) CONGRESSIONAL ADD: AESIR Reusable Liquid Oxygen/Liquefied Natural Gas (LOX/LNG) Launch 2.050 0.000 0.000 0.0 (U) In FY 2004: Explored ead tested 30,000 pound thrust LOX/LNG engine to establish the feasibility of the basic propulsion concepts. This effort could lead to a relatively high performance, reusable 30,000 pound, pump-fed, regeneratively cooled chamber propulsion system and a two-stage-to-orbit vehicle system concept; effort could also lead to a reusable, configurable-plume propulsion system and target vehicle design. The target vehicle will be a relatively simple pressure-fed design to support plume detection and discrimination test objectives. (U) In FY 2005: Not Applicable. (U) (U) In FY 2006: Not Applicable. (U) In FY 2007: Not Applicable. (U) (U) In FY 2004: Expanded the capabilities of an existing integrated engineering, modeling, simulation, and design tool that supports rapid modeling and collaborative Research. Development, Test, and Evaluation of advanced spacecraft and launch vehicles. Enhanced capabilities include modeling of more complex launch vehicle concepts, and vehicle atmospheric reentry performance for studies of future tactical conventional weapons delivery. (U) In FY 2005: Expand to predict performance benefits and impacts for new technologies on a variety of spacecraft, spaceff, and responsive force systems. This includes unique subject areas such as satellite field-of-view studies, space radiation effects, directed energy lethality and unlerability, and implementation of hadware-in-the-loop simulation. 4.589 3.965 0.000 0.00	(U)	In FY 2007: Complete payload and bus fabrication. Perform functional and payload and bus. Complete system level integration of payload and microsa functional and environmental tests of integrated system. Begin integration v ground control system and satellite software simulations. Perform simulated missions operations training.	l environmental tests of tellite and complete vith launch vehicle. Integrate l mission operations for						
(1) CONGRESSIONAL ADD: AESIR Reusable Liquid Oxygen/Liqueited Natural Gas (LOX/LNG) Launch 2.050 0.000 0.000 0.00 Vehicle Technology. (1) In FY 2004: Fabricated and tested 30.000 pound thrust LOX/LNG engine to establish the feasibility of the basic propulsion concepts. This effort could lead to a relatively high performance, reusable 30.000 pound-pda regeneratively cooled chamber propulsion system and a two-stage-to-orbit vehicle system concept; effort could also lead to a reusable, configurable-plume propulsion system and target vehicle design. The target vehicle will be a relatively simple pressure-fed design to support plume detection and discrimination test objectives. (1) (1) In FY 2005: Not Applicable. (1) (1) In FY 2007: Not Applicable. (1) (1) In FY 2007: Not Applicable. (1) (1) In FY 2004: Expanded the capabilities of an existing integrated engineering, modeling, simulation, and design tool that supports rapid modeling and collaborative Research, Development, Test, and Evaluation of advanced spacecraft and launch vehicles. Enhanced capabilities include modeling of more complex launch vehicle snace three force systems. This includes unique subject areas such as satellite field-of-view studies, space radiation effects, directed energy lethality and vulnerability, and implementation of hardware-in-the-loop simulation. (1) In FY 2007: Not Applicable. (1) (1) In FY 2007: Not Applicable. (2)	(U)			2 0 5 0	0.000	0.000	0.000		
 Venter Figure 100025. Venter Figure 2004: Fabricated and tested 30,000 pound thrust LOX/LNG engine to establish the feasibility of the basic propulsion concepts. This effort could lead to a relatively high performance, reusable 30,000 pound, pump-fed, regeneratively cooled chamber propulsion system and a two-stage-to-orbit vehicle system concept; effort could also lead to a reusable, configurable-plume propulsion system and target vehicle design. The target vehicle will be a relatively simple pressure-fed design to support plume detection and discrimination test objectives. (U) In FY 2005: Not Applicable. (U) In FY 2006: Not Applicable. (U) CONGRESSIONAL ADD: Integrated Spacecraft Engineering Tool (ISET). (I) In FY 2004: Expanded the capabilities of an existing integrated engineering, modeling, simulation, and design tool that supports rapid modeling and collaborative Research. Development, Trest, and Evaluation of advanced spacecraft and launch vehicles. Enhanced capabilities include modeling of more complex launch vehicle concepts, and vehicle atmospheric reentry performance for studies of future tactical conventional weapons delivery. (U) In FY 2005: Expand to predict performance benefits and impacts for new technologies on a variety of spacecraft, spacerift, and responsive force systems. This includes unique subject areas such as satellite field-of-view studies, space radiation effects, directed energy lethality and vulnerability, and implementation of hardware-in-the-loop simulation. (U) In FY 2007: Not Applicable. (U) U) CONGRESSIONAL ADD: Vehicle Risk Reduction. Project 3324 	(U)	CONGRESSIONAL ADD: AESIR Reusable Liquid Oxygen/Liquefied Nat	ural Gas (LOX/LNG) Launch	2.050	0.000	0.000	0.000		
 (U) In FY 2005: Not Applicable. (U) In FY 2006: Not Applicable. (U) In FY 2007: Not Applicable. (U) CONGRESSIONAL ADD: Integrated Spacecraft Engineering Tool (ISET). (U) CONGRESSIONAL ADD: Integrated Spacecraft Engineering, modeling, simulation, and design tool that supports rapid modeling and collaborative Research, Development, Test, and Evaluation of advanced spacecraft and launch vehicles. Enhanced capabilities include modeling of more complex launch vehicle concepts, and vehicle atmospheric reentry performance for studies of future tactical conventional weapons delivery. (U) In FY 2005: Expand to predict performance benefits and impacts for new technologies on a variety of spacecraft, spacelift, and responsive force systems. This includes unique subject areas such as satellite field-of-view studies, space radiation effects, directed energy lethality and vulnerability, and implementation of hardware-in-the-loop simulation. (U) In FY 2006: Not Applicable. (U) CONGRESSIONAL ADD: Vehicle Risk Reduction. 4.589 3.965 0.000 0.00 Project 3834 	(U)	In FY 2004: Fabricated and tested 30,000 pound thrust LOX/LNG engine to the basic propulsion concepts. This effort could lead to a relatively high per pound, pump-fed, regeneratively cooled chamber propulsion system and a tw system concept; effort could also lead to a reusable, configurable-plume prop vehicle design. The target vehicle will be a relatively simple pressure-fed de detection and discrimination test objectives.	o establish the feasibility of formance, reusable 30,000 wo-stage-to-orbit vehicle pulsion system and target esign to support plume						
 (U) In FY 2006: Not Applicable. (U) In FY 2007: Not Applicable. (U) (U) CONGRESSIONAL ADD: Integrated Spacecraft Engineering Tool (ISET). (I) In FY 2004: Expanded the capabilities of an existing integrated engineering, modeling, simulation, and design tool that supports rapid modeling and collaborative Research, Development, Test, and Evaluation of advanced spacecraft and launch vehicles. Enhanced capabilities include modeling of more complex launch vehicle concepts, and vehicle atmospheric reentry performance for studies of future tactical conventional weapons delivery. (U) In FY 2005: Expand to predict performance benefits and impacts for new technologies on a variety of spacecraft, spacelift, and responsive force systems. This includes unique subject areas such as satellite field-of-view studies, space radiation effects, directed energy lethality and vulnerability, and implementation of hardware-in-the-loop simulation. (U) In FY 2005: Not Applicable. (U) UONGRESSIONAL ADD: Vehicle Risk Reduction. Project 3834 	(U)	In FY 2005: Not Applicable.							
 (U) In FY 2007: Not Applicable. (U) (U) CONGRESSIONAL ADD: Integrated Spacecraft Engineering Tool (ISET). (U) In FY 2004: Expanded the capabilities of an existing integrated engineering, modeling, simulation, and design tool that supports rapid modeling and collaborative Research, Development, Test, and Evaluation of advanced spacecraft and launch vehicles. Enhanced capabilities include modeling of more complex launch vehicle concepts, and vehicle atmospheric reentry performance for studies of future tactical conventional weapons delivery. (U) In FY 2005: Expand to predict performance benefits and impacts for new technologies on a variety of spacecraft, spacelift, and responsive force systems. This includes unique subject areas such as satellite field-of-view studies, space radiation effects, directed energy lethality and vulnerability, and implementation of hardware-in-the-loop simulation. (U) In FY 2007: Not Applicable. (U) CONGRESSIONAL ADD: Vehicle Risk Reduction. Project 3834 	(U)	In FY 2006: Not Applicable.							
 (U) (U) CONGRESSIONAL ADD: Integrated Spacecraft Engineering Tool (ISET). (U) In FY 2004: Expanded the capabilities of an existing integrated engineering, modeling, simulation, and design tool that supports rapid modeling and collaborative Research, Development, Test, and Evaluation of advanced spacecraft and launch vehicles. Enhanced capabilities include modeling of more complex launch vehicle concepts, and vehicle atmospheric reentry performance for studies of future tactical conventional weapons delivery. (U) In FY 2005: Expand to predict performance benefits and impacts for new technologies on a variety of spacecraft, spacelift, and responsive force systems. This includes unique subject areas such as satellite field-of-view studies, space radiation effects, directed energy lethality and vulnerability, and implementation of hardware-in-the-loop simulation. (U) In FY 2007: Not Applicable. (U) CONGRESSIONAL ADD: Vehicle Risk Reduction. Project 3834 	(U)	In FY 2007: Not Applicable.							
 (U) CONGRESSIONAL ADD: Integrated Spacecraft Engineering Tool (ISET). (U) In FY 2004: Expanded the capabilities of an existing integrated engineering, modeling, simulation, and design tool that supports rapid modeling and collaborative Research, Development, Test, and Evaluation of advanced spacecraft and launch vehicles. Enhanced capabilities include modeling of more complex launch vehicle concepts, and vehicle atmospheric reentry performance for studies of future tactical conventional weapons delivery. (U) In FY 2005: Expand to predict performance benefits and impacts for new technologies on a variety of spacecraft, spacelift, and responsive force systems. This includes unique subject areas such as satellite field-of-view studies, space radiation effects, directed energy lethality and vulnerability, and implementation of hardware-in-the-loop simulation. (U) In FY 2005: Not Applicable. (U) In FY 2007: Not Applicable. (U) CONGRESSIONAL ADD: Vehicle Risk Reduction. (D) Project 3834 	(U)								
 (U) In FY 2005: Expand to predict performance benefits and impacts for new technologies on a variety of spacecraft, spacelift, and responsive force systems. This includes unique subject areas such as satellite field-of-view studies, space radiation effects, directed energy lethality and vulnerability, and implementation of hardware-in-the-loop simulation. (U) In FY 2006: Not Applicable. (U) In FY 2007: Not Applicable. (U) (U) CONGRESSIONAL ADD: Vehicle Risk Reduction. Project 3834 R-1 Shopping List - Item No. 26-13 of 26-28 Exhibit R-2a (PE 060340) 	(U) (U)	CONGRESSIONAL ADD: Integrated Spacecraft Engineering Tool (ISET). In FY 2004: Expanded the capabilities of an existing integrated engineering design tool that supports rapid modeling and collaborative Research, Develo of advanced spacecraft and launch vehicles. Enhanced capabilities include r launch vehicle concepts, and vehicle atmospheric reentry performance for st conventional weapons delivery.	, modeling, simulation, and pment, Test, and Evaluation nodeling of more complex udies of future tactical	1.660	0.991	0.000	0.000		
(U) In FY 2006: Not Applicable. (U) In FY 2007: Not Applicable. (U) (D) CONGRESSIONAL ADD: Vehicle Risk Reduction. R-1 Shopping List - Item No. 26-13 of 26-28 Exhibit R-2a (PE 060340	(U)	In FY 2005: Expand to predict performance benefits and impacts for new te spacecraft, spacelift, and responsive force systems. This includes unique sul field-of-view studies, space radiation effects, directed energy lethality and ve implementation of hardware-in-the-loop simulation.	chnologies on a variety of bject areas such as satellite ulnerability, and						
(U) In FY 2007: Not Applicable. (U) (U) (U) CONGRESSIONAL ADD: Vehicle Risk Reduction. 4.589 3.965 0.000 0.000 Project 3834 R-1 Shopping List - Item No. 26-13 of 26-28 Exhibit R-2a (PE 060340	(U)	In FY 2006: Not Applicable.							
(U) (U) CONGRESSIONAL ADD: Vehicle Risk Reduction. 4.589 3.965 0.000 0.0 Project 3834 R-1 Shopping List - Item No. 26-13 of 26-28 Exhibit R-2a (PE 060340)	(U)	In FY 2007: Not Applicable.							
(U) CONGRESSIONAL ADD: Vehicle Risk Reduction. 4.589 3.965 0.000 0.0 Project 3834 R-1 Shopping List - Item No. 26-13 of 26-28 Exhibit R-2a (PE 060340	(U)						0		
Project 3834 R-1 Shopping List - Item No. 26-13 of 26-28 Exhibit R-2a (PE 060340	(U)	CONGRESSIONAL ADD: Vehicle Risk Reduction.		4.589	3.965	0.000	0.000		
	Pro	ject 3834 R-1 Shoppir	ng List - Item No. 26-13 of 26-28			Exhibit R-2a (P	E 0603401F)		

Exhibit R-2a, R	DT&E Projec	t Justifica	tion			DATE	February 2	2005
BUDGET ACTIVITY 03 Advanced Technology Development (ATD)		PE N 0603 Tecl	UMBER AND TIT 3401F Advan hnology	rLE ced Spacecra	aft	PROJECT NUMBE 3834 Integrate Demonstratior	R AND TITLE d Space Tec IS	hnology
 (U) In FY 2004: Validated the cost and performance of a rocked propulsion system. Validated cost, mass properties, and stat tanks through hardware fabrication and destructive testing. segmented pair through ground hot fire testing. (U) In FY 2005: Complete fabrication of all tank body compore body sections, fabrication of the structural test fixture, structure the tank dome component tools. Initiate completion of fabrication of fabrication of the remaining tanks. (U) In FY 2006: Not Applicable. (U) Total Cost 	et engine module u ructural performar Demonstrated in nent and assembly ctural testing of th prication of both th	used in the RS nee of the RSL tegrated opera tools, fabricat e bodies, and the remaining ta	LV main V segmented tion of a tion of all tank fabrication of ank assembly	30.1	160	23.376	21.958	26.272
 (U) <u>C. Other Program Funding Summary (\$ in Millions)</u> <u>FY 2004</u> <u>FY 2005</u> <u>Actual Estimate</u> (U) Related Activities: PE 0602601F, Spacecraft Technology. (U) PE 0603605F, Advanced Weapons Technology. This project has been coordinated through the (U) Reliance process to harmonize efforts and eliminate duplication. (U) <u>D. Acquisition Strategy</u> Not Applicable. 	<u>FY 2006</u> <u>Estimate</u>	<u>FY 2007</u> <u>Estimate</u>	<u>FY 2008</u> Estimate	<u>FY 2009</u> <u>Estimate</u>	FY 2010 Estimate	Estimate	<u>Cost to</u> <u>Complete</u>	<u>Total Cost</u>
Project 3834	R-1 Shoppin	ig List - Item No.	26-14 of 26-28				Exhibit R-2a (P	E 0603401F)

		Exhibit R-2	2a, RDT&E	E Project J	ustificatio	on			DATE	February	2005
BUDG 03 A (ET ACTIVITY dvanced Technology Developme	nt (ATD)			PE NUM 060340 Techno	BER AND TITLE D 1F Advance Dlogy	ed Spacecra	ft 44	OJECT NUMBE 00 Space Sy	R AND TITLE	ection
	Cost (\$ in Millions)	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	Cost to	Total
		Actual	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Complete	
4400	Space Systems Protection	6.534	6.913	3.310	3.410	3.457	3.747	4.117	4.193	Continuing	TBD
	Quantity of RD1&E Articles	0	0	0	0	0	0	0	0		
, []	This project develops and demonstrates environments. The project performs as project also develops technologies that strategies for detecting, avoiding, and o	s tools, instrum ssessments of o mitigate ident operating in a l	nents, and mit critical compo ified vulnerab hostile space e	igation technic nents and subs ilities. Techn nvironment.	ques required systems, and e ologies are de	to assure oper evaluates susce veloped and d	ation of U.S. s eptibility and lemonstrated t	space assets i vulnerability o support bal	n potentially h to RF and lase anced satellite	ostile warfigh r threats. Thi protection	ting s
(U) (U)	B. Accomplishments/Planned Progra MAJOR THRUST: Use multi-threat a communication, and other responses to energy threats.	am (\$ in Milli assessment too o various cand	ons) ls to assess sp idate RF and l	ace-based elec aser counterm	tro-optical, easures and d	irected	<u>FY 200</u> 0.9'	04 EY 77	<u>ř 2005</u> 1.002	<u>FY 2006</u> 0.889	<u>FY 2007</u> 0.935
(U)	In FY 2004: Enhanced existing satelli of satellite electro-optical sensor effect RF and laser susceptibility and potenti susceptibility and potential for mitigati communications.	te subsystem r ts. Assessed e al mitigation to ion techniques	esponse data c lectro-optical echniques. As for key satell:	collection thro designs of pla ssessed directe ite subsystems	ugh laborator nned space sy d energy thre s, such as	y test beds stems for at					
(U)	In FY 2005: Investigate models for RI integration into single satellite commu analysis tool. Apply constellation anal	F and laser res nications and p lysis tool to wa	ponse in com power subsyst argaming exer	nunications ar em models int cises and asse	nd power subs o satellite con ss efficacy.	ystems and astellation					
(U)	In FY 2006: Perform predicative analysis tool. Be constellation analysis tool.	ysis of laborate egin modeling	ory data to val of mitigation	idate models l techniques and	being develop d incorporate	ed for the into					
(U)	In FY 2007: Verify mitigation models effectiveness.	s against test d	ata and comm	ence predictiv	e analysis of t	echnique					
(U)				1	-h		1.0		2.000	2.042	2.076
(U)	IVIAJOK THKUST: Develop passive s	satemite counte	simeasures and	i mitigation te	childres for a	current and	1.5	55	2.000	2.045	2.070
(U)	In FY 2004: Completed plasma shield design trade studies and analyses to de awareness technologies on space syste deployable shields and triggered auton	l design and de termine the im ms operations natic gain cont	efine potential npact of satelli . Investigated rol for RF three	system applic te self-protect mitigation tec eats.	ations. Refin ion and situat hnologies suc	ed selected ional h as					
Proje	ect 4400		F	R-1 Shopping Lis	st - Item No. 26	15 of 26-28				Exhibit R-2a (F	PE 0603401F)
					471						

BUDGET ACTIVITY PE NUMBER AND TITLE PROJECT NUMBER AND TITLE 03 Advanced Technology Development (ATD) Image: Construction of the constene construction of th		Exhibit R-2a, RDT&E Project Jus	tification		DATE	February 2	2005		
 In FY 2005: Investigate and identify candidate threat mitigation technologies for principle satellite subsystems, such as shielding and terminal protection techniques for multi-chip modules, reconfigurable processors/architectures, and anti-jam moderns for uplink subsystems. In FY 2006: Develop prospective threat technologies and initiate comprehensive testing for space application. In FY 2007: Integrate protection into space experiment for demonstration and validation. In FY 2007: Integrate protection into space experiment for demonstration and validation. MAIOR THRUST: Develop visible and near-infrared laser protection technologies. In FY 2004: Investigated image interpretation processing techniques, Image Quality Measurement verse the National Image Interpretation System. Performed calibration of laser laboratory systems. Performed analysis of Thompson array testing in laser laboratory. Enhanced investigation of laser interference effects on readout electronics for new Kodak focal plane array sensor subsystem components. In FY 2006: Design and fabricate an optical sensor subsystem incorporating adaptive signal processing techniques. Sume sensor subsystem incorporating adaptive signal processing techniques. Bevelop optical sensor subsystem integration technologies. Conduct ground test of optical sensor subsystem integration techniques using solutions such as acousto-optical sensor subsystem integration technology. In FY 2006: Demonstrate visible and near-infrared laser protection technologies. Conduct ground test of optical sensor subsystem for prosecvice protection technology. In FY 2007: Coordinate space admonstration of protective technology. Identify technology transfer opportunities and report findings to major commands. CONGRESSIONAL ADD: Hardening Technologies for Sarellite Protection. S.417 3.470 0.000 FY 2004: Examined, evaluated, and summarized potential protection techniques sens, and perform	BUD 03 /	GET ACTIVITY Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603401F Advanced Technology	Spacecraft	PROJECT NUMBER AND TITLE 4400 Space Systems Protection				
 (U) In FY 2006: Develop prospective threat technologies and initiate comprehensive testing for space application. (U) In FY 2007: Integrate protection into space experiment for demonstration and validation. (U) MAIOR THRUST: Develop visible and near-infrared laser protection technologies. 0.785 0.435 0.378 (U) In FY 2004: Envestigated image interpretation processing techniques, Image Quality Measurement verse the National Image Interpretation System. Performed calibration of laser laboratory systems. Performed analysis of Thompson array testing in laser laboratory. Enhanced investigation of laser interference effects on readout electronics for new Kodak focal plane array sensor subsystem components. (U) In FY 2005: Design and fabricate an optical sensor subsystem incorporating adaptive signal processing techniques. Develop optical sensor subsystem threat mitigation techniques using solutions such as acousto-optical switches or other developed limiters to deflect incoming laser energy from the focal plane array. (U) In FY 2006: Demonstrate visible and near-infrared laser protection technologies. Conduct ground test of optical sensor subsystem incorporating adaptive signal processing. Coordinate space simulation testing of prospective protection technology. Identify technology transfer opportunities and report findings to major commands. (U) In FY 2004: Examined, evaluate of fentionegies for Stallite Protection. (U) In FY 2004: Examined, evaluated, and summarized potential protection techniques that are acceptable to systems designers, with a goal of minimal impacts of additional weight and power, integration issues, and performance loss. Established relationships with commercial system designers to explored version 1 of the Stallite Survivability Module code to include ability to analyze both RF and laser effects within the Statellite Toolity transmite. 	(U)	In FY 2005: Investigate and identify candidate threat mitigation technologies for prisubsystems, such as shielding and terminal protection techniques for multi-chip mod processors/architectures, and anti-jam modems for uplink subsystems.	inciple satellite lules, reconfigurable						
 (U) In FY 2007: Integrate protection into space experiment for demonstration and validation. (U) MAJOR THRUST: Develop visible and near-infrared laser protection technologies. (U) In FY 2004: Investigated image interpretation processing techniques, Image Quality Measurement verse the National Image Interpretation System. Performed calibration of laser laboratory systems. Performed analysis of Thompson array testing in laser laboratory. Enhanced investigation of laser interference effects on readout electronics for new Kodak focal plane array sensor subsystem components. (U) In FY 2005: Design and fabricate an optical sensor subsystem incorporating adaptive signal processing techniques. Develop optical sensor subsystem incorporating laser energy from the focal plane array. (U) In FY 2006: Demonstrate visible and near-infrared laser protection technologies. Conduct ground test of optical sensor subsystem incorporating selective mitigation approaches. Develop selected protection technology. (U) In FY 2007: Coordinate space demonstration of protective technology. (U) In FY 2007: Coordinate space demonstration of protective technology. (U) In FY 2004: Examined, evaluated, and summarized potential protection technology transfer opportunities and report findings to major commands. (U) In FY 2004: Examined, evaluated, and summarized potential protection techniques share acceptable to systems designers, with a goal of minimal impacts of additional weight and power, integration issues, and performance loss. Established relationships with commercial system designers to explore acceptable to systems. Readow for the subscience of the satellite Survivability Module code to include ability to analyze both RF and laser effects within the Satellite Survivability Module code to include ability to analyze both RF and laser effects within the Satellite Toroxice. 	(U)	In FY 2006: Develop prospective threat technologies and initiate comprehensive tes application.	ting for space						
(U) MAJOR THRUST: Develop visible and near-infrared laser protection technologies. 0.785 0.435 0.378 (U) In FY 2004: Investigated image interpretation processing techniques, Image Quality Measurement verse the National Image Interpretation System. Performed calibration of laser laboratory systems. Performed analysis of Thompson array testing in laser laboratory. Enhanced investigation of laser interference effects on readout electronics for new Kodak focal plane array sensor subsystem components. 0.185 0.435 0.378 (U) In FY 2005: Design and fabricate an optical sensor subsystem incorporating adoptive signal processing techniques. Develop optical sensor subsystem threat mitigation techniques using solutions such as acousto-optical switches or other developed limiters to deflect incoming laser energy from the focal plane array. 0.1872 (U) In FY 2006: Demonstrate visible and near-infrared laser protection technologies. Conduct ground test of optical sensor subsystem incorporating selective mitigation approaches. Develop selected protection technology. 0.1187 (U) In FY 2007: Coordinate space demonstration of protective technology. 3.417 3.470 0.000 (U) UN FY 2004: Examined, evaluated, and summarized potential protection. 3.417 3.470 0.000 0 (U) In FY 2004: Examined, evaluated, and summarized potential protection. 0 consplete version i systems. 3.417 3.470 0.000 0	(U) (U)	In FY 2007: Integrate protection into space experiment for demonstration and validate	ation.						
 (U) In FY 2005: Design and fabricate an optical sensor subsystem incorporating adaptive signal processing techniques. Develop optical sensor subsystem threat mitigation techniques using solutions such as acousto-optical switches or other developed limiters to deflect incoming laser energy from the focal plane array. (U) In FY 2006: Demonstrate visible and near-infrared laser protection technologies. Conduct ground test of optical sensor subsystem incorporating selective mitigation approaches. Develop selected protection techniques and evaluate effectiveness as a laser mitigation technology. (U) In FY 2007: Coordinate space demonstration of protective technology. Identify technology transfer opportunities and report findings to major commands. (U) CONGRESSIONAL ADD: Hardening Technologies for Satellite Protection techniques that are acceptable to systems designers, with a goal of minimal impacts of additional weight and power, integration issues, and performance loss. Established relationships with commercial system designers to explore acceptable approaches for applications to commercial systems. Began laboratory testing of prospective protection techniques that are acceptable approaches for applications to commercial systems. Began laboratory testing of prospective protection techniques that applicable for enhanced survivability. Completed Version 1 of the Satellite Environement of the Satellite Environement of the Satellite Environement of the Satellite Environement of the Satellite Brotection techniques both RF and laser effects within the Satellite Environement of the Satellite Envindent of the Satellite Environement o	(U) (U)	MAJOR THRUST: Develop visible and near-infrared laser protection technologies. In FY 2004: Investigated image interpretation processing techniques, Image Quality the National Image Interpretation System. Performed calibration of laser laboratory analysis of Thompson array testing in laser laboratory. Enhanced investigation of la effects on readout electronics for new Kodak focal plane array sensor subsystem com	Measurement verse systems. Performed ser interference nponents.	0.785	0.435	0.378	0.399		
 atray. (U) In FY 2006: Demonstrate visible and near-infrared laser protection technologies. Conduct ground test of optical sensor subsystem incorporating selective mitigation approaches. Develop selected protection techniques and evaluate effectiveness as a laser mitigation technique of optical sensor subsystems. Coordinate space simulation testing of prospective protection technology. (U) In FY 2007: Coordinate space demonstration of protective technology. Identify technology transfer opportunities and report findings to major commands. (U) (U) CONGRESSIONAL ADD: Hardening Technologies for Satellite Protection. (U) In FY 2004: Examined, evaluated, and summarized potential protection techniques that are acceptable to systems designers, with a goal of minimal impacts of additional weight and power, integration issues, and performance loss. Established relationships with commercial system designers to explore acceptable approaches for applications to commercial systems. Began laboratory testing of prospective protection techniques, filters, rugates, and/or limiters applicable for enhanced survivability. Completed Version 1 of the Satellite Survivability Module code to include ability to analyze both RF and laser effects within the Satellite Toolkit framework. 	(U)	In FY 2005: Design and fabricate an optical sensor subsystem incorporating adaptive techniques. Develop optical sensor subsystem threat mitigation techniques using sol acousto-optical switches or other developed limiters to deflect incoming laser energy	te signal processing lutions such as a from the focal plane						
 (U) In FY 2007: Coordinate space demonstration of protective technology. Identify technology transfer opportunities and report findings to major commands. (U) (U) CONGRESSIONAL ADD: Hardening Technologies for Satellite Protection. (U) In FY 2004: Examined, evaluated, and summarized potential protection techniques that are acceptable to systems designers, with a goal of minimal impacts of additional weight and power, integration issues, and performance loss. Established relationships with commercial system designers to explore acceptable approaches for applications to commercial systems. Began laboratory testing of prospective protection techniques, filters, rugates, and/or limiters applicable for enhanced survivability. Completed Version 1 of the Satellite Survivability Module code to include ability to analyze both RF and laser effects within the Satellite Toolkit framework. 	(U)	In FY 2006: Demonstrate visible and near-infrared laser protection technologies. C optical sensor subsystem incorporating selective mitigation approaches. Develop set techniques and evaluate effectiveness as a laser mitigation technique of optical sensor Coordinate space simulation testing of prospective protection technology.	onduct ground test of lected protection or subsystems.						
 (U) (U) CONGRESSIONAL ADD: Hardening Technologies for Satellite Protection. (U) In FY 2004: Examined, evaluated, and summarized potential protection techniques that are acceptable to systems designers, with a goal of minimal impacts of additional weight and power, integration issues, and performance loss. Established relationships with commercial system designers to explore acceptable approaches for applications to commercial systems. Began laboratory testing of prospective protection techniques, filters, rugates, and/or limiters applicable for enhanced survivability. Completed Version 1 of the Satellite Survivability Module code to include ability to analyze both RF and laser effects within the Satellite Toolkit framework 	(U)	In FY 2007: Coordinate space demonstration of protective technology. Identify tech opportunities and report findings to major commands.	hnology transfer						
systems designers, with a goal of minimal impacts of additional weight and power, integration issues, and performance loss. Established relationships with commercial system designers to explore acceptable approaches for applications to commercial systems. Began laboratory testing of prospective protection techniques, filters, rugates, and/or limiters applicable for enhanced survivability. Completed Version 1 of the Satellite Survivability Module code to include ability to analyze both RF and laser effects within the Satellite Toolkit framework	(U) (U) (U)	CONGRESSIONAL ADD: Hardening Technologies for Satellite Protection. In FY 2004: Examined, evaluated, and summarized potential protection techniques	that are acceptable to	3.417	3.470	0.000	0.000		
the Suterite Tookit Hunework.		systems designers, with a goal of minimal impacts of additional weight and power, in performance loss. Established relationships with commercial system designers to exapproaches for applications to commercial systems. Began laboratory testing of protechniques, filters, rugates, and/or limiters applicable for enhanced survivability. Co of the Satellite Survivability Module code to include ability to analyze both RF and I the Satellite Toolkit framework.	ntegration issues, and plore acceptable spective protection ompleted Version 1 laser effects within						
(U) In FY 2005: Continue evaluation of possible protection techniques that are acceptable to systems designers with a goal of minimum impact of additional weight and power, integration issues, and performance loss. Maintain relationship with commercial systems designers to explore acceptable	(U)	In FY 2005: Continue evaluation of possible protection techniques that are acceptable designers with a goal of minimum impact of additional weight and power, integration performance loss. Maintain relationship with commercial systems designers to explore	le to systems n issues, and ore acceptable						
Project 4400 R-1 Shopping List - Item No. 26-16 of 26-28 Exhibit R-2a (PE 060	Pro	ject 4400 R-1 Shopping List - It	tem No. 26-16 of 26-28			Exhibit R-2a (P	E 0603401F)		

	Exhibit R-2a, RDT&E Project Justification								DATE	DATE February 2005		
BUD 03 /	GET ACTIVITY Advanced Technology Devel	lopment (ATD)		PE N 060: Tec l	UMBER AND TI 3401F Advan hnology	TLE Iced Spacec	raft 44	ROJECT NUMBEI 400 Space Sy	R AND TITLE stems Protection		
(U) (U) (U)	approaches for application to co techniques, filters, rugates, and protection techniques emerging promising protection techniques designers into the Satellite Surv In FY 2006: Not Applicable. In FY 2007: Not Applicable. Total Cost	ommercial syste /or limiters appl from FY 2004 s. Incorporate to vivability Modul	ms. Expand la icable for enha effort. Begin o est results and e code.	aboratory testin anced survivabi development of feed back from	g of prospectiv ility. Develop f field tests of t n commercial s	ve protection promising he most ystems	6.	534	6.913	3.310 3.410		
(U)	C. Other Program Funding Su	<u>1mmary (\$ in N</u> EX 2004	<u>fillions</u>) EV 2005	EV 2006	EV 2007	EV 2008	EV 2000	EV 2010	EV 2011	Cost to		
(U) (U) (U) (U)	Related Activities: PE 0602102F, Materials. PE 0602601F, Spacecraft Technology. PE 0603605F, Advanced Weapons Technology. This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication. D. Acquisition Strategy Not Applicable.	<u>Actual</u>	Estimate	Estimate	<u>Estimate</u>	Estimate	Estimate	Estimate	Estimate	Complete Total Cost		
Pro	oject 4400			R-1 Shoppiı	ng List - Item No.	26-17 of 26-28				Exhibit R-2a (PE 0603401F)		

	E	Exhibit R-2	2a, RDT&E	Project J	ustificatio	on			DATE	February 2	2005
BUDG 03 A	ET ACTIVITY dvanced Technology Developme	nt (ATD)			PE NUM 060340 Techno	BER AND TITLE 1 F Advance blogy	d Spacecra	ft 502	DJECT NUMBE 21 Space Sy	R AND TITLE	ivability
	Cost (\$ in Millions)	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	Cost to	Total
5021		Actual	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Complete	
5021	Space Systems Survivability	3.992	4.733	4.583	4.769	4.830	5.239	5.350	5.449	Continuing	TBD
			•	0	0	0	0	0	0		
	This project develops and demonstrates that must continue operation despite na interactions including electrical charge	technologies tural space ha buildup and e	to improve sp zards. It devel lectronics fail	ace system su ops and demo ures due to bo	rvivability and nstrates cost-c th single radia	d reliability of effective soluti tion events an	current and for ons to mitigat d long-term ra	uture Departm te hazardous s adiation doses	nent of Defens pace environi	se space systemental	ns
(U) (U)	B. Accomplishments/Planned Progra MAJOR THRUST: Develop sensors to degrade the operation of satellite, commintegration, launch, validation, and oper ionospheric hazard specification and for	am (\$ in Milli o specify and a munication, na eration of instr precasting.	ons) forecast condi wigation, and umentation to	tions in the spa surveillance s provide impro	ace environmo ystems. Supp oved space rac	ent that ort liation and	<u>FY 200</u> 2.53	<u>)4 FY</u> 38	<u>2005</u> 3.263	<u>FY 2006</u> 3.261	<u>FY 2007</u> 3.643
(U)	In FY 2004: Validated solar disturband Designed instrument and data plan for radiation belt that limits choices for spa- conceptual design to include interplane miniaturized white-light camera. Deve miniaturize energetic particle, neutral of space weather hazards.	ce forecast alg joint-agency r acecraft orbits etary in situ pla eloped initial r lensity, and lo	orithms deriven nission to map . Expanded sp asma and mag nicro- and nan w energy plas	ed from all-sky the high-inte bace weather f netic field sen o-technology ma sensors ne	y heliospheric nsity region o orecasting sys sors in addition based concep eded to charac	imager. f the stem on to ts to cterize					
(U) (U)	In FY 2005: Complete initial all-sky in military/civilian operational forecasters Force radiation belt mapping satellite. magnetic field, and all-sky white light optimal micro- and nano-technology particle, neutral density, and low-energ In FY 2006: Calibrate and integrate re	mage based so s. Continue de Investigate jo cameras for in ath to achieve gy plasma sens lativistic parti	lar disturbanc evelopment of int-agency dev clusion on int maximum dep ors for space cle sensor onto	e forecast algo relativistic pa velopment of r erplanetary mi ployable, high weather characo o Air Force rac	orithms and tra rticle sensor f niniaturized p crosatellites. est capability cterization. diation belt m	ansition to for Air lasma, Determine energetic apping					
(U)	satellite. Complete concept design for next-generation solar hazard detection sensors for energetic particle, neutral d In FY 2007: Complete integration of r satellite. Identify space test opportunit heliospheric imager for solar hazard det	joint-agency s system. Initia ensity, low-en elativistic part y and begin co etection. Com	space-based co te concept des ergy plasma s icle sensor on ponstruction of plete concept	oronagraph and ign of micro- pace weather to Air Force ra joint agency c design of next	d heliospheric and nano-tech characterizatio adiation belt r oronagraph an- generation m	imager for mology on. napping nd iniaturized					
Proje	ect 5021		F	R-1 Shopping Lis	st - Item No. 26-	18 of 26-28				Exhibit R-2a (P	E 0603401F)
					474						

BUDGET ACTIVITY PE NUMBER AND TILE 1003 Advanced Technology Development (ATD) PE NUMBER AND TILE 1003 Advanced Spacecraft Technology PROJECT NUMBER AND TILE 5021 Space Systems Survivability space weather sensors and begin development of engineering models. 100 AdVAR TIREUST: Conduct collaborative space and laboratory experiments and develop hardware and software tools to improve the survivability of spacecraft power, communications, navigation, and surveillance systems. 0.481 0.349 0.358 0.367 (1) In FY 2004: Enhanced testing of miniaturized charge control system and began design of space experiment for the haraflaus geosynchronous environment. Developed a space experiment concept to validate on-orbit electrical power generation and particle scattering capabilities of space tether. Developed initial suite of comprehensive spacecraft environment effect tools for operational use by integrating full range of environment specification and forccast models with spacecraft haraft, trans-ionospheric link degrade capacitate darge on of active anterna and passive deciciton hardware rogitzments. Complete indegrade design of active anterna and passive deciciton bardware requirements. Complete indegrade design of or space experiment to actively explore space particle dynamics and demonstrate raliation bet remediation or hazard mitigation. Refine space tether experiment concept and finality space hardware requirements. Complete hardware suite selection and begin fabrication of phyload for space experiment to actively explose space particle dynamics and demonstrate raliation bet remediation technologies. 0.1121 0.964 0.759 (1) In FY 2007: Construct space plasma control experiment plan combining statellite chinologies.		Exhibit R-2a, RDT&E Project	t Justification		DATE	February 2	2005
space weather sensors and begin development of engineering models. (U) (I)	BUD 03 /	GET ACTIVITY Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603401F Advanced Technology	Spacecraft	PROJECT NUM 5021 Space	ivability	
(U) MAIOR THRUST: Conduct collaborative space and laboratory experiments and develop hardware and 0.481 0.349 0.358 0.367 software tools to improve the survivability of spacecraft power, communications, navigation, and surveillance systems. 0.481 0.349 0.358 0.367 (U) In FY 2004: Enhanced testing of miniaturized charge control system and begin design of space experiment for the hazardous geosynchronous environment. Developed a space experiment concept to validate on-orbit electrical power generation and particle scattering capabilities of space tester. Developed initial suite of comprehensive spacecraft environment effect tools for operational use by integrating full range of environment specification tools. Investigated design of active antenna and passive detection hardware for space experiment to demonstrate techniques of lowering radiation bet intensities to protect satellites. 10 (U) In FY 2005: Complete design and laboratory testing of miniaturized geosynchronous charge control system and explore options for on -obit demonstration of hazard mitigation. Refine space tether experiment concept and finalize space hardware requirements. Complete integration of ionospheric and satellite drug efforts into spacecraft environment effect tools suite. Conflue tabrication of payload for space capariment payload no space capariment payload and establish joint-agency collaboration for spacelish. Teoretime expansion of spacecraft environment effect tools suite. Conflue darbication of payload in space and metaliation belt remediation technologies using electromaspatic wave technologies. (U) In FY 2005: Complete pay and cadiaton belt remediation technologies using electromaspatic w		space weather sensors and begin development of engineering models.					
(U) In FY 2004: Enhanced testing of miniaturized charge control system and began design of space experiment concept to validate on-orbit electrical power generation and particle scattering capabilities of space tether. Developed initial suite of comprehensive spacecraft environment effect tools for operational use by integrating full range of environment specification tools. Investigated design of active antenna and passive detection hardware for space experiment to demonstrate techniques of lowering radiation belt intensities to protect statellites. (U) In FY 2005: Complete design and laboratory testing of miniaturized geosynchronous charge control system and explore options for on-orbit demonstration of hazard mitigation. Refine space tether experiment concept and finalize space hardware requirements. Complete integration of ionospheric and satellite drag effects into spacecraft environment effect tool suite. Complete hardware suite selection and begin fairication of payload for space experiment pace curityel explore space particle dynamics and demonstrate radiation belt remediation technologies. (U) In FY 2006: Develop space plasma control experiment plan combining satellite charge control and tether propulsion and particle remediation concepts. Begin integration of dynamic space particle climatology and radiation belt remediation belt, remediation belt, molecular belt, forecast models, into spacecraft environment effect tool suite to include dynamic space particle climatologies. (U) In FY 2007: Construct space plasma control experiment payload and establish joint-agency collaboration for spaceflight. Continue expansion of spacecraft environment effect tool suite to include dynamic space particle climatologies. 0.973 1.121	(U) (U)	MAJOR THRUST: Conduct collaborative space and laboratory experiments software tools to improve the survivability of spacecraft power, communication surveillance systems.	and develop hardware and ons, navigation, and	0.481	0.349	0.358	0.367
 (U) In FY 2005: Complete design and laboratory testing of miniaturized geosynchronous charge control system and explore options for on-orbit demonstration of hazard mitigation. Refine space tether experiment concept and finalize space hardware requirements. Complete integration of ionospheric and satellite drag effects into spacecraft environment effect tool suite. Complete hardware suite selection and begin fabrication of payload for space experiment to actively explore space particle dynamics and demonstrate radiation belt remediation technologies. (U) In FY 2006: Develop space plasma control experiment plan combining satellite charge control and tether propulsion and particle remediation concepts. Begin integration of dynamic space particle climatology and radiation belt forecast models into spacecraft environment effect tool suite. Continue fabrication of payload to demonstrate radiation belt remediation technologies using electromagnetic wave technologies. (U) In FY 2007: Construct space plasma control experiment payload and establish joint-agency collaboration for space(fight. Continue expansion of spacecraft environment effect tool suite to include dynamic space particle climatologies and integration onto Air Force test satellite. (U) (U) MAJOR THRUST: Develop technology to warn of spacecraft radiation, charging, and kinetic impact 0.973 1.121 0.964 0.759 hazards and to provide space environment situational awareness and anomaly resolution capability for Department of Defense space systems. (U) In FY 2004: Completed development of first-generation data assimilation models specifying global radiation levels based on single compact environment anomaly sensor inputs. Completed concept design for space text detectors comprising distributed anomaly resolution sensors and begin hardware Project 5021 	(U)	In FY 2004: Enhanced testing of miniaturized charge control system and beg experiment for the hazardous geosynchronous environment. Developed a spa validate on-orbit electrical power generation and particle scattering capabilitie Developed initial suite of comprehensive spacecraft environment effect tools integrating full range of environment specification and forecast models with s trans-ionospheric link degradation, and satellite drag specification tools. Inve antenna and passive detection hardware for space experiment to demonstrate tradiation belt intensities to protect satellites.	an design of space ce experiment concept to es of space tether. for operational use by pacecraft hazard, estigated design of active techniques of lowering				
 (U) In FY 2006: Develop space plasma control experiment plan combining satellite charge control and tether propulsion and particle remediation concepts. Begin integration of dynamic space particle climatology and radiation belt forecast models into spacecraft environment effect tool suite. Continue fabrication of payload to demonstrate radiation belt remediation technologies using electromagnetic wave technologies. (U) In FY 2007: Construct space plasma control experiment payload and establish joint-agency collaboration for spaceflight. Continue expansion of spacecraft environment effect tool suite to include dynamic space particle climatologies and forecast models. Complete radiation belt remediation payload and begin calibration and integration onto Air Force test satellite. (U) (U) MAJOR THRUST: Develop technology to warn of spacecraft radiation, charging, and kinetic impact 0.973 1.121 0.964 0.759 hazards and to provide space environment situational awareness and anomaly resolution capability for Department of Defense space systems. (U) In FY 2004: Completed development of first-generation data assimilation models specifying global radiation levels based on single compact environment anomaly sensor inputs. Completed concept design for space hazard detectors comprising distributed anomaly resolution sensors and begin hardware Project 5021 R-1 Shopping List - Item No. 26-19 of 26-28 Exhibit R-2a (PE 0603401F) 	(U)	In FY 2005: Complete design and laboratory testing of miniaturized geosynci system and explore options for on-orbit demonstration of hazard mitigation. I experiment concept and finalize space hardware requirements. Complete inte satellite drag effects into spacecraft environment effect tool suite. Complete h begin fabrication of payload for space experiment to actively explore space pa demonstrate radiation belt remediation technologies.	hronous charge control Refine space tether gration of ionospheric and hardware suite selection and article dynamics and				
 (U) In FY 2007: Construct space plasma control experiment payload and establish joint-agency collaboration for spaceflight. Continue expansion of spacecraft environment effect tool suite to include dynamic space particle climatologies and forecast models. Complete radiation belt remediation payload and begin calibration and integration onto Air Force test satellite. (U) (U) MAJOR THRUST: Develop technology to warn of spacecraft radiation, charging, and kinetic impact (U) MAJOR THRUST: Develop technology to warn of spacecraft radiation, charging, and kinetic impact (U) 0.973 (D) 1.121 (D) 0.964 (D) 0.759 (D) hazards and to provide space environment situational awareness and anomaly resolution capability for Department of Defense space systems. (U) In FY 2004: Completed development of first-generation data assimilation models specifying global radiation levels based on single compact environment anomaly sensor inputs. Completed concept design for space hazard detectors comprising distributed anomaly resolution sensors and begin hardware Project 5021 R-1 Shopping List - Item No. 26-19 of 26-28 Exhibit R-2a (PE 0603401F) 	(U)	In FY 2006: Develop space plasma control experiment plan combining satelly propulsion and particle remediation concepts. Begin integration of dynamic s and radiation belt forecast models into spacecraft environment effect tool suite payload to demonstrate radiation belt remediation technologies using electron	ite charge control and tether pace particle climatology e. Continue fabrication of nagnetic wave technologies.				
 (U) (U) MAJOR THRUST: Develop technology to warn of spacecraft radiation, charging, and kinetic impact (U) MAJOR THRUST: Develop technology to warn of spacecraft radiation, charging, and kinetic impact (U) MAJOR THRUST: Develop technology to warn of spacecraft radiation, charging, and kinetic impact (U) MAJOR THRUST: Develop technology to warn of spacecraft radiation awareness and anomaly resolution capability for Department of Defense space systems. (U) In FY 2004: Completed development of first-generation data assimilation models specifying global radiation levels based on single compact environment anomaly sensor inputs. Completed concept design for space hazard detectors comprising distributed anomaly resolution sensors and begin hardware Project 5021 R-1 Shopping List - Item No. 26-19 of 26-28 Exhibit R-2a (PE 0603401F) 	(U)	In FY 2007: Construct space plasma control experiment payload and establish for spaceflight. Continue expansion of spacecraft environment effect tool suit particle climatologies and forecast models. Complete radiation belt remediati calibration and integration onto Air Force test satellite.	h joint-agency collaboration te to include dynamic space on payload and begin				
 (U) MAJOR THRUST: Develop technology to warn of spacecraft radiation, charging, and kinetic impact (D) hazards and to provide space environment situational awareness and anomaly resolution capability for Department of Defense space systems. (U) In FY 2004: Completed development of first-generation data assimilation models specifying global radiation levels based on single compact environment anomaly sensor inputs. Completed concept design for space hazard detectors comprising distributed anomaly resolution sensors and begin hardware Project 5021 R-1 Shopping List - Item No. 26-19 of 26-28 Exhibit R-2a (PE 0603401F) 	(U)						
Project 5021 R-1 Shopping List - Item No. 26-19 of 26-28 Exhibit R-2a (PE 0603401F)	(U) (U)	MAJOR THRUST: Develop technology to warn of spacecraft radiation, char hazards and to provide space environment situational awareness and anomaly Department of Defense space systems. In FY 2004: Completed development of first-generation data assimilation mor radiation levels based on single compact environment anomaly sensor inputs. for space hazard detectors comprising distributed anomaly resolution sensors	ging, and kinetic impact resolution capability for odels specifying global Completed concept design and begin hardware	0.973	1.121	0.964	0.759
	Pro	ject 5021 R-1 Shopping	g List - Item No. 26-19 of 26-28			Exhibit R-2a (P	E 0603401F)

		Exhibi	t R-2a, RD	T&E Proje	ct Justifica	ition			DATE	February 2	2005
BUD 03 A	GET ACTIVITY Advanced Technology Deve	elopment (ATI))		PE N 0603 Tec	UMBER AND TI 3401F Advan hnology	TLE Iced Spaceci	raft 5	ROJECT NUMBE 021 Space Sy	R AND TITLE stems Survi	vability
(U)	development. Refined detailed demonstrate the feasibility of s In FY 2005: Advance global r number of sensor inputs to imp distributed space hazard sensor experiment to remediate severe	d design of activ satellite protection radiation hazard prove accuracy a rs needed for spa- e radiation envir	e wave and ele on technologies situational awa nd timeliness. ace situational onments. Plan	ctron beam spa s. areness model o Complete labo awareness. Co for space test	ace experiment development by oratory demons omplete design flight of active	to y expanding trations of of active wave wave and					
(U)	distributed sensor technologies In FY 2006: Develop filter-ba utilizing complete inputs avail design and finalize requirement distributed anomaly resolution environment anomaly sensor to radiation belt remediation expe	s. sed optimization able from compa its and conceptu and spacecraft of o diagnose seven eriment.	a algorithms to act environmer al design of rac effects sensor s e radiation env	determine full at anomaly sens diation, plasma suite. Complete vironments exp	particle energy sor. Determine , chemical, and e construction o ected during ac	y spectra impact sensor impact effect of compact ctive wave					
(U)	In FY 2007: Employ full ener sensor data bases into dynamic Commence construction of har sensor. Calibrate and integrate environment on Air Force test	gy spectra algor c climatological rdware for space c compact enviro satellite.	ithms to conve model for anor demonstratior onment anomal	rt entire compa naly resolution of the distribu y sensor for di	act environmen a and space syst ated anomaly re agnosing sever	t anomaly tem design. esolution e radiation					
(U)	Total Cost						3.	992	4.733	4.583	4.769
(U) (U) (U) (U)	C. Other Program Funding S PE 0602601F, Spacecraft Technology. This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication. D. Acquisition Strategy Not Applicable.	<u>Eummary (\$ in 1</u> <u>FY 2004</u> <u>Actual</u>	<u>FY 2005</u> <u>Estimate</u>	<u>FY 2006</u> <u>Estimate</u>	<u>FY 2007</u> <u>Estimate</u>	<u>FY 2008</u> <u>Estimate</u>	<u>FY 2009</u> <u>Estimate</u>	<u>FY 2010</u> <u>Estimate</u>	<u>FY 2011</u> <u>Estimate</u>	<u>Cost to</u> , <u>Complete</u> -	<u>Total Cos</u> t
Pro	ject 5021			R-1 Shoppi	ng List - Item No	. 26-20 of 26-28				Exhibit R-2a (Pl	E 0603401F)

		Exhibit R-2	2a, RDT&E	Project J	ustificatio	on			DATE	February	2005
BUDG 03 A	ET ACTIVITY Ivanced Technology Developme	nt (ATD)			PE NUM 060340 Techno	BER AND TITLE D 1F Advance Dlogy	ed Spacecra	ft 50	ROJECT NUMBE	R AND TITLE Missiles Tec	chnology
	Cost (\$ in Millions)	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	Cost to	Total
		Actual	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Complete	
5083	Ballistic Missiles Technology	6.274	6.798	5.491	3.859	3.928	4.248	4.32	4.397	Continuing	TBD
	Quantity of RD1&E Articles	0	0	0	0	0	0	(0		
	This project develops, integrates, and d leveloping robust, low maintenance in precision instrumentation for next gene B Accomplishments/Planned Progra	emonstrates a ertial navigatio eration missile	dvanced techn on instruments systems.	ologies for su to sustain cu	stainment and rrent ballistic	l modernizatio missile system	n of strategic is, as well as p EX 200	ballistic mis provide new,	siles. The proj small, low-po Y 2005	ect focuses on wered, high FY 2006	FY 2007
(U) (U)	MAJOR THRUST: Develop, integrate emerging vehicle designs and other tec critical missile technology concepts to	e, and demonst chnologies that support future	trate advanced t sustain curre e space force a	navigation in nt strategic mi pplication and	strumentation ssile systems. l strategic sys	applied to Provide tems.	3.13	<u>37</u>	3.399	2.746	<u>1.930</u>
(U)	In FY 2004: Evaluated the most prom advanced gyro and accelerometer syste power navigation instrument system th	ising navigation ems into a breat at approaches	on instrumenta adboard demos or exceeds ba	tion technolog nstration of a 1 llistic missile	gies and integ reduced size a mission goals	rated the and reduced					
(U)	In FY 2005: Downselect to the most a generation of ballistic missiles. Evaluate performance goals. Demonstrate and we performance goals.	dvanced navig ate the designs validate impro	gational instru and provide i ved navigation	mentation desi mprovements nal technology	igns for the ne to meet the es designs that	ext stablished can meet					
(U)	In FY 2006: Explore further laborator navigation instrumentation designs. In demonstration units. Initiate engineerin provide improvements to meet establis	y proof-of-con itiate fabricati 1g developmen hed performat	acept of the mo ion of navigati nt tests. Evalu- nce goals.	ost promising on instrument ate instrument	next generations and enginee t performance	on missile ring and					
(U)	In FY 2007: Develop and integrate en ground test in environments relevant to and provide improvements to meet esta planning.	gineering desi o subsequent fl ablished perfor	gn next genera light test cond rmance goals.	ation missile n itions. Evalua Initiate flight	avigation sys ate system per test demonst	tems and formance ration					
(U) (U)	MAJOR THRUST: Develop, integrate vehicle designs to provide robust, flexi systems.	e, and demonst ble, lower cos	trate advanced t solutions for	navigation te sustaining cu	chnologies w rrent strategic	ith new missile	3.13	37	3.399	2.745	1.929
(U)	In FY 2004: Integrated advanced there controllability and selective targeting.	mal materials i Demonstrated	into long-glide l lower-cost, r	vehicles to probust leading	rovide greater edge, and con	trol surface					
Proje	ct 5083		F	R-1 Shopping Lis	st - Item No. 26	-21 of 26-28				Exhibit R-2a (F	PE 0603401F)
					477						

		Exhibi	t R-2a, RD	T&E Proje	ct Justifica	ition			DATE	February 2	2005
BUD 03	OGET ACTIVITY Advanced Technology Devel	opment (ATE))		PE N 060 Tec	UMBER AND TI 3401F Advan hnology	TLE Iced Spacecr	raft 5	ROJECT NUMBE 083 Ballistic I	R AND TITLE Missiles Tecl	hnology
	materials in a test flight to valid robust on-board navigation inst times the gravitational force in a	ate improved p ruments and rar all axes in labor	roperties for funge safety devi age safety devi atory tests.	uture vehicle de lees can withsta	esigns. Demon and loads great	strated that er than 100					
(U)	In FY 2005: Complete advance greater controllability and select and control surface materials an robust advanced future vehicle of on-board navigation instruments gravitational force in all axes in	d thermal mate tive targeting. d initiate down designs. Use re s and range safe flight test dem	rials design in Evaluate demo selection to ca esults of labora ety devices to onstrations.	tegrated with le onstration resul andidates proje itory testing to withstand loads	ong-glide vehic ts of advanced cted to provide improve the ca s greater than 1	eles to provide leading edge lower cost, pability of 00 tiems the					
(U)	In FY 2006: Initiate long-term instrumentation and range safet	plan for sled te y devices. Cha	sting of high-g racterize instru races with ex	ravitational for imentation perf	ce tolerant nav formance in qu bed.	igation iescent					
(U)	In FY 2007: Continue long-terr with test facilities in preparation instrumentation and range safety safety devices with associated p interfaces in 100 times the gravit design interfaces experimental t	n planning and n for sled testin y devices. Mea latform hardwa itational force f est bed.	initiate long-le g of high-gravi sure performa ire, power sour light-like vibra	ead hardware a itational force t nce of navigati rces, support so ation environm	cquisition and colerant navigation instrumenta of instrumenta of tware, and co ents. Continue	coordination tion tion and range mmunication system level					
(U)	Total Cost						6.	274	6.798	5.491	3.859
(U) (U) (U) (U) (U)	C. Other Program Funding Survey PE 0601102F, Defense Research Sciences. PE 0602601F, Space Technology. PE 0603311F, Ballistic Missile Technology. PE 0603601F, Conventional Weapons Technology. PE 0603851F, Intercontinental Ballistic Missile-Dem/Val.	<u>Immary (\$ in N</u> <u>FY 2004</u> <u>Actual</u>	<u>Aillions)</u> <u>FY 2005</u> <u>Estimate</u>	<u>FY 2006</u> <u>Estimate</u>	<u>FY 2007</u> <u>Estimate</u>	<u>FY 2008</u> <u>Estimate</u>	<u>FY 2009</u> <u>Estimate</u>	<u>FY 2010</u> <u>Estimate</u>	<u>FY 2011</u> <u>Estimate</u>	Cost to Complete	<u>Fotal Cos</u> t
Pro	oject 5083			R-1 Shoppi	ng List - Item No	. 26-22 of 26-28				Exhibit R-2a (PE	E 0603401F)

Exhibit R-2a,	RDT&E Project Justification	DATE February 2005		
BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603401F Advanced Spacecraft Technology	PROJECT NUMBER AND TITLE 5083 Ballistic Missiles Technology		
 (U) <u>C. Other Program Funding Summary (\$ in Millions)</u> PE 0604851F, (U) Intercontinental Ballistic Missile-EMD. (U) PE 0605860F, Rocket System Launch Program-Space. This project has been coordinated through the (U) Reliance process to harmonize efforts and eliminate duplication. (U) <u>D. Acquisition Strategy</u> Not Applicable. 				
Project 5083	R-1 Shopping List - Item No. 26-23 of 26-28	Exhibit R-2a (PE 0603401F)		

	Exhibit R-2	2a, RDT&E	Project J	ustificatio	on			DATE	February	2005
BUDGET ACTIVITY 03 Advanced Technology Developme	nt (ATD)			PE NUM 060340 Techno	BER AND TITLE D IF Advance Dlogy	ed Spacecra	ft 682	DJECT NUMBE 2 J Spacecra	R AND TITLE	
Cost (\$ in Millions)	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	Cost to	Total
	Actual	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Complete	
682J Spacecraft Vehicles	26.082	21.232	6.607	10.020	11.858	10.281	13.065	13.301	Continuing	TBD
			0	0	0	0	0	0		I
This project develops and demonstrate technologies, including cryogenic cool Energy storage work focuses on lightw satellite missions. The project's power	s compact, low ing technologi eight nickel hy distribution ef	-cost, spaceer es. Power ger drogen and so forts focus on	aft and launch heration activi odium sulfur s producing lig	n vehicle powe ties focus on l pacecraft batt thweight, hig	er generation, ightweight, lo eries and flyw h-efficiency, s	storage, distri w-cost, low-v heel energy s tandardized p	bution, and th olume, and su torage system ower busses f	ermal manage rvivable solar s for extended or use on futu	ement r cell arrays. l (five to ten y re space syste	vear) ems.
 (U) <u>B. Accomplishments/Planned Progra</u> (U) MAJOR THRUST: Developed and event technologies such as multi-junction so cell arrays, and radiation resistant solar 	am (\$ in Milli aluated perfor lar cells, advar r cell modules.	ons) mance of spac nced thin film	e conventiona solar cells, lig	al power gene htweight flex	ration ible solar	<u>FY 200</u> 2.6	<u>04 FY</u> 55	<u>2005</u> 2.146	<u>FY 2006</u> 1.606	<u>FY 2007</u> 2.238
 (U) In FY 2004: Demonstrated integration arrays. Completed full space qualifica lattice mismatch multi-junction solar c (U) In FY 2005: Demonstrate methods for blankets. Develop balloon-flight calib 	a methods for t tion testing of ells into test co interconnection ration samples	hin-film solar 28% efficient oupons. ng thin-film so for lattice mi	cells on polyr solar cells. Ir blar modules i smatch solar c	ner substrates ntegrated 28% nto array-size cells.	into full efficient d thin-film					
(U) In FY 2006: Complete space environmentation testing of lattice mismatch m	nental testing of ulti-junction so	of thin-film so plar cells.	lar cells and n	nodules. Perf	orm					
(U) In FY 2007: Perform radiation testing thin-film solar array. Demonstrate rol	of five to six -to-roll produc	junction solar ction of thin-fi	cells. Constr lm solar cells	uct flight harc on polymer s	lware for ubstrates.					
(U)(U) MAJOR THRUST: Develop technolo cryocoolers and integration componen	gies for long li ts for space ap	fe, efficient, l plications.	ow-vibration,	lightweight m	nechanical	1.6	33	1.263	1.046	1.470
(U) In FY 2004: Investigated developmen Developed and characterized performa cryocooler for advanced space surveill cryocooler technologies for regenerativ to cryocooler designs	t of high capac ince of second- ance and track we and recuper	eity, multi-stag generation de ing sensor. E ative cycle de	ge, low temper signs model h xplored develovices to transi	rature cryococ iigh capacity t opment of cor tion enabling	oler system. en Kelvin nponent technology					
(U) In FY 2005: Refine development of h to meet the needs of high resolution, s focal planes and optics. Expand devel	igh capacity, n pace-based infr opment of con	nulti-stage, low rared surveilla ponent cryoc	v-temperature nce and tracki ooler technolo	cryocooler te ing sensors wi ogies for reger	chnologies ith larger herative and					
Project 682J		F	R-1 Shopping Lis	st - Item No. 26	-24 of 26-28				Exhibit R-2a (F	PE 0603401F)
				480						

	Exhibit R-2a, RDT&E Project Jus		DATE	February 2	2005	
BUD 03 A	GET ACTIVITY Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603401F Advanced Sp Technology	acecraft	PROJECT NUME 682J Spacec	BER AND TITLE raft Vehicles	
(U)	recuperative cycle devices to transition enabling technology to cryocooler designs. It cryogenic integration technologies, including thermal switches, in a relevant environ. In FY 2006: Complete development of low temperature flight qualified high capacit demonstrate performance of cryocooler and control electronics integrated with focal environment. Improve performance of key critical components including compresso	Demonstrate ment. ty cryocooler and plane in a relevant or, electronics, and				
(U)	heat exchangers. In FY 2007: Assess various advanced technologies such as micro-electro-mechanica and other concepts to further reduce cryocooler mass and improve performance for s situational awareness applications. Initiate advanced concept development program multi-temperature and large focal plane cooling requirements for space-based space other mission applications.	al, optical cooling, pace based to support surveillance and				
(U)						
(U)	MAJOR THRUST: Develop composites for launch vehicle and spacecraft structure applications, such as launch vehicle shrouds, thermal protection structures, and space	s and space e antennas.	5.212	2.335	1.973	3.327
(U)	In FY 2004: Refined spacecraft to demonstrate multi-functional structures technolog fabrication of multi-functional spacecraft bus components for small satellites. Fligh Evolved Expendable Launch Vehicle secondary payload adapter. Explored the desig linerless composite cryogenic tanks. Developed large deployable optics structures un nanotechnology-enhanced materials.	gies. Completed t qualified full-scale gn and characterized sing				
(U)	In FY 2005: Further refine spacecraft to demonstrate multi-functional structures tec demonstrate sub-scale linerless composite cryogenic tanks. Fabricate and characteri large deployable optics systems using nanotechnology-enhanced materials.	hnologies. Ground ze components for				
(U)	In FY 2006: Develop ultra-lightweight, high-structural efficiency mirror support str mirrors. Demonstrate qualification-level performance of all-composite payload adap structures for Evolved Expendable Launch Vehicles.	uctures for space oters and fairing				
(U)	In FY 2007: Demonstrate space qualification-level performance for large diameter l fairing. Transition multi-functional structures technology to unmanned aerial vehicl community. Demonstrate space qualification-level performance for 25-meters long deployable structures.	aunch vehicle e and launch vehicle ultralightweight				
(U)						
(U)	MAJOR THRUST: Develop technologies for spacecraft structural controls and mec applications such as advanced high power solar array subsystems, sensitive payload and miniature payload isolation systems.	hanisms for on-orbit isolation systems,	5.841	2.602	1.982	2.985
(U)	In FY 2004: Refined launch vibration isolation and primary and secondary payload	isolation systems to				
Pro	ject 682J R-1 Shopping List - I	tem No. 26-25 of 26-28			Exhibit R-2a (P	E 0603401F)

BUDGET ACTIVITY PE NUMBER AND TILE 063 Advanced Technology Development (ATD) PROJECT NUMEER AND TILE 0663041F Advanced Spacecraft PROJECT NUMEER AND TILE 0623047F PROJECT NUMEER AND TILE 0633047F PROJECT NUMEER AND TILE 0633047F		Exhibit R-2a, RDT&E Project Ju	DATE February 2005				
meet specific launch vehicle requirements. Flight demonstrated operational active acoustic attenuation systems. Flight demonstrated low-shock multiple payload adapter technologies. Designed flight hardware to demonstrate smart docking and deployment mechanisms. Developed micro-electro-mechanical attitude control components. Designed flight hardware to demonstrate smart docking and deployment mechanisms. Developed micro-electro-mechanical attitude control components. Designed flight hardware to demonstrate smart docking and deployment mechanisms. (U) In FY 2005: Refine launch vibration isolation and primary and secondary payload isolation systems to meet specific launch vehicle requirements. Complete development of low-shock multiple payload adapter technologies. Perform flight qualification-length and toking and deployment hardware. Integrate micro-electro-mechanical attitude control system with integrated energy storage. Demonstrate space qualification-level performance for mainturized vibration isolation systems for optical payloads. (I) In FY 2007: Ground demonstrate frage qualification-level performance for mainturized energy storage. Demonstrate space qualification-level performance for mainture storage qualification-level performance for mainturized energy storage. Demonstrate space qualification-level performance for mainsture storage energy storage. Demonstrate space qualification-level performance for mainsture storage energy storage. Demonstrate space qualification-level performance for mainsture storage energy storage. Demonstrate space qualification-level performance for mainsture storage energy storage. D	BUD 03 /	GET ACTIVITY Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603401F Advanced Sp Technology	acecraft	PROJECT NUME 682J Spacec	BER AND TITLE	
c) by the performance of performance for miniaturized vibration isolation systems for optical payloads. (U) In FY 2007: Ground demonstrate full multi-axis flywheel attitude control system with integrated energy storage. Demonstrate space qualification-level performance for passive vibro-acoustic damping devices to mitigate launch vehicle acoustic loads. Flight demonstrate on-orbit docking and fluid transfer mechanisms. (U) CONGRESSIONAL ADD: Thin Film Amorphous Solar Arrays. 4.590 7.434 0.000 0.000 (U) CONGRESSIONAL ADD: Thin Film Amorphous Solar Arrays. 4.590 7.434 0.000 0.000 (U) CONGRESSIONAL ADD: Thin Film Amorphous Solar Arrays. 4.590 7.434 0.000 0.000 (U) In FY 2004: Developed monolithic integration technology for the low-cost interconnection of thin film amorphous silicon solar cells. Developed lightweight solar array support structures and deployment mechanisms enabled by the thin film solar cells. Demonstrated the reproducible manufacture of large-area amorphous silicon solar cells no polyment substrate monolithic integration of amorphous silicon solar cells no polymer substrate. 1 1 FY 2005: Demonstrate process capable of high volume, roll-to-roll production of amorphous silicon solar cells on polymer substrates. 2.734 4.461 0.000 0.000 (U) In FY 2006: Furthered efforts to develop larger fairings for expendable rockets. Refined the design, analysis, and fabrication techniques for very lar	(U)	meet specific launch vehicle requirements. Flight demonstrated operational active systems. Flight demonstrated low-shock multiple payload adapter technologies. It isolation mechanisms for large free-flying solar array and integrated with thin film Designed flight hardware to demonstrate smart docking and deployment mechanism micro-electro-mechanical attitude control components. In FY 2005: Refine launch vibration isolation and primary and secondary payload meet specific launch vehicle requirements. Complete development of operational attenuation systems. Complete development of low-shock multiple payload adapter Perform flight qualification testing of smart docking and deployment hardware. In micro-electro-mechanical attitude control components with conventional attitude of In FY 2006: Develop rapid-slew, fast tracking gimbal technology to allow sub-or	e acoustic attenuation Built deployment and a solar cell components. I solation systems to active acoustic er technologies. Integrate control systems. bital space situational				
(U) In FY 2007: Ground demonstrate full multi-axis flywheel attitude control system with integrated energy storage. Demonstrate space qualification-level performance for passive vibro-acoustic damping devices to mitigate launch vehicle acoustic loads. Flight demonstrate on-orbit docking and fluid transfer mechanisms. (U) CONGRESSIONAL ADD: Thin Film Amorphous Solar Arrays. 4.590 7.434 0.000 0.000 (U) In FY 2004: Developed monolithic integration technology for the low-cost interconnection of thin film amorphous silicon solar cells. Developed lightweight solar array support structures and deployment mechanisms enabled by the thin film solar array support structures and deployment mechanisms enabled by the thin film solar cells. Demonstrate the reproducible manufacture of large-area amorphous silicon cells necessary for population of the thin film solar arrays. In FY 2005: Demonstrate process capable of high volume, roll-to-roll production of amorphous silicon solar cells on polymer substrates. 2.734 4.461 0.000 0.000 (U) In FY 2004: Furthered efforts to develop larger fairings for expendable rockets. Refined the design, analysis, and fabrication techniques for very large payload fairings through the development of sub-scale components and test articles. 2.734 4.461 0.000 0.000 (U) In FY 2005: Fabricate full-scale fairings and adapters based on design inputs from FY 2004 and Project 682J R-1 Shopping List - Item No. 26-26 of 26-28 Exhibit R-2a (PE 0603401F)	(0)	awareness missions. Demonstrate space qualification-level performance for minia isolation systems for optical payloads.	aturized vibration				
(U) CONGRESSIONAL ADD: Thin Film Amorphous Solar Arrays. 4.590 7.434 0.000 0.000 (U) In FY 2004: Developed monolithic integration technology for the low-cost interconnection of thin film amorphous silicon solar cells. Developed lightweight solar array support structures and deployment mechanisms enabled by the thin film solar cells. Demonstrated the reproducible manufacture of large-area amorphous silicon cells necessary for population of the thin film solar arrays. 10 In FY 2005: Demonstrate monolithic integration of amorphous silicon solar cells in roll-to-roll processing. Demonstrate process capable of high volume, roll-to-roll production of amorphous silicon solar cells on polymer substrates. 2.734 4.461 0.000 0.000 (U) In FY 2005: Not Applicable. 2.734 4.461 0.000 0.000 (U) In FY 2004: Furthered efforts to develop larger fairings for expendable rockets. Refined the design, analysis, and fabrication techniques for very large payload fairings through the development of sub-scale components and test articles. 2.734 4.461 0.000 0.000 (U) In FY 2005: Fabricate full-scale fairings and adapters based on design inputs from FY 2004 and Project 682J R-1 Shopping List - Item No. 26-26 of 26-28 Exhibit R-2a (PE 0603401F)	(U)	In FY 2007: Ground demonstrate full multi-axis flywheel attitude control system storage. Demonstrate space qualification-level performance for passive vibro-aco to mitigate launch vehicle acoustic loads. Flight demonstrate on-orbit docking and mechanisms.	with integrated energy ustic damping devices 1 fluid transfer				
(U) CONGRESSIONAL ADD: Thin Film Amorphous Solar Arrays. 4.590 7.434 0.000 0.000 (U) In FY 2004: Developed monolithic integration technology for the low-cost interconnection of thin film amorphous silicon solar cells. Developed lightweight solar array support structures and deployment mechanisms enabled by the thin film solar cells. Demonstrated the reproducible manufacture of large-area amorphous silicon cells necessary for population of the thin film solar arrays. 1000 0.000 0.000 (U) In FY 2005: Demonstrate monolithic integration of amorphous silicon solar cells in roll-to-roll production of amorphous silicon solar cells on polymer substrates. 1000 1000 0.000 (U) In FY 2006: Not Applicable. 1000 1000 0.000 0.000 (U) In FY 2007: Not Applicable. 1000 0.000 0.000 0.000 (U) In FY 2004: Furthered efforts to develop larger fairings for expendable rockets. Refined the design, analysis, and fabrication techniques for very large payload fairings through the development of sub-scale components and test articles. 2.734 4.461 0.000 0.000 (U) In FY 2005: Fabricate full-scale fairings and adapters based on design inputs from FY 2004 and Project 682J R-1 Shopping List - Item No. 26-26 of 26-28 Exhibit R-2a (PE 0603401F)	(U)			1 500	7.424	0.000	0.000
 (U) In FY 2005: Demonstrate monolithic integration of amorphous silicon solar cells in roll-to-roll production of amorphous silicon solar cells on polymer substrates. (U) In FY 2006: Not Applicable. (U) In FY 2007: Not Applicable. (U) (U) CONGRESSIONAL ADD: Robust Aerospace Composite Materials/Structures. (U) In FY 2004: Furthered efforts to develop larger fairings for expendable rockets. Refined the design, analysis, and fabrication techniques for very large payload fairings through the development of sub-scale components and test articles. (U) In FY 2005: Fabricate full-scale fairings and adapters based on design inputs from FY 2004 and Project 682J R-1 Shopping List - Item No. 26-26 of 26-28 	(U) (U)	CONGRESSIONAL ADD: Thin Film Amorphous Solar Arrays. In FY 2004: Developed monolithic integration technology for the low-cost interco amorphous silicon solar cells. Developed lightweight solar array support structure mechanisms enabled by the thin film solar cells. Demonstrated the reproducible n large-area amorphous silicon cells necessary for population of the thin film solar a	onnection of thin film and deployment nanufacture of rrays.	4.590	7.434	0.000	0.000
 (U) In FY 2006: Not Applicable. (U) In FY 2007: Not Applicable. (U) (U) CONGRESSIONAL ADD: Robust Aerospace Composite Materials/Structures. (U) In FY 2004: Furthered efforts to develop larger fairings for expendable rockets. Refined the design, analysis, and fabrication techniques for very large payload fairings through the development of sub-scale components and test articles. (U) In FY 2005: Fabricate full-scale fairings and adapters based on design inputs from FY 2004 and Project 682J R-1 Shopping List - Item No. 26-26 of 26-28 	(U)	In FY 2005: Demonstrate monolithic integration of amorphous silicon solar cells processing. Demonstrate process capable of high volume, roll-to-roll production of solar cells on polymer substrates.	in roll-to-roll of amorphous silicon				
 (U) In FY 2007: Not Applicable. (U) (U) CONGRESSIONAL ADD: Robust Aerospace Composite Materials/Structures. (U) In FY 2004: Furthered efforts to develop larger fairings for expendable rockets. Refined the design, analysis, and fabrication techniques for very large payload fairings through the development of sub-scale components and test articles. (U) In FY 2005: Fabricate full-scale fairings and adapters based on design inputs from FY 2004 and Project 682J R-1 Shopping List - Item No. 26-26 of 26-28 Exhibit R-2a (PE 0603401F) 	(U)	In FY 2006: Not Applicable.					
 (U) (U) (U) CONGRESSIONAL ADD: Robust Aerospace Composite Materials/Structures. (U) In FY 2004: Furthered efforts to develop larger fairings for expendable rockets. Refined the design, analysis, and fabrication techniques for very large payload fairings through the development of sub-scale components and test articles. (U) In FY 2005: Fabricate full-scale fairings and adapters based on design inputs from FY 2004 and Project 682J R-1 Shopping List - Item No. 26-26 of 26-28 Exhibit R-2a (PE 0603401F) 	(U)	In FY 2007: Not Applicable.					
 (U) In FY 2004: Furthered efforts to develop larger fairings for expendable rockets. Refined the design, analysis, and fabrication techniques for very large payload fairings through the development of sub-scale components and test articles. (U) In FY 2005: Fabricate full-scale fairings and adapters based on design inputs from FY 2004 and Project 682J R-1 Shopping List - Item No. 26-26 of 26-28 Exhibit R-2a (PE 0603401F) 	(U)	CONCRESSIONAL ADD: Robust Agrospace Composite Materials/Structures		2 734	1 461	0.000	0.000
(U) In FY 2005: Fabricate full-scale fairings and adapters based on design inputs from FY 2004 and Project 682J R-1 Shopping List - Item No. 26-26 of 26-28 Exhibit R-2a (PE 0603401F)	(U)	In FY 2004: Furthered efforts to develop larger fairings for expendable rockets. If analysis, and fabrication techniques for very large payload fairings through the develop components and test articles.	Refined the design, velopment of sub-scale	2.734	4.401	0.000	0.000
Project 682J R-1 Shopping List - Item No. 26-26 of 26-28 Exhibit R-2a (PE 0603401F)	(U)	In FY 2005: Fabricate full-scale fairings and adapters based on design inputs from	n FY 2004 and				
	Pro	oject 682J R-1 Shopping List	- Item No. 26-26 of 26-28			Exhibit R-2a (Pl	E 0603401F)

		Exhibi	t R-2a, RD	T&E Proje	ct Justifica	tion			DATE	February 2	2005	
BUD 03 /	BUDGET ACTIVITY 03 Advanced Technology Development (ATD)					PE NUMBER AND TITLE PROJE 0603401F Advanced Spacecraft 682J Technology				ECT NUMBER AND TITLE Spacecraft Vehicles		
(U) (U) (U)	supporting Small Business Inno fairing/adapter configurations. Investigate influence on practica demonstrate degree of conserva diameter to support large optics In FY 2006: Not Applicable. In FY 2007: Not Applicable.	vation Research Demonstrate la al controlled fla tism in current experiments w	h contracts for rge scale out-o ws and perfor design practice ill be considered	new structure : f-autoclave com mance. Test st es. Fairing des ed for this dem	fabrication pro- mponent fabric ructures to fail- igns up to ten r onstration prog	cesses and ations. ure to neters in gram.						
(U) (U)	J) CONGRESSIONAL ADD: Boron Energy Cell Development. 3.417 0.991 J) In FY 2004: Increased energy conversion efficiency of the Boron Energy Cell, which converts radioisotope beta emissions into electric current. Quantified mission impacts for Department of Defense 3.417 0.991								0.991	0.000	0.000	
(U) (U) (U)	In FY 2005: Integrate Boron Energy Cell Storage Packs capa applications. In FY 2006: Not Applicable. In FY 2007: Not Applicable.	nergy Cell with ble of supplyin	battery and ca g burst power	pacitor storage for selected hig	e device to prov gh value Air Fo	ide Boron rce						
(U)	Total Cost						26.	082	21.232	6.607	10.020	
(U)	C. Other Program Funding Su	<u>ımmary (\$ in N</u>	<u>(Iillions)</u>									
(U) (U) (U) (U) (U)	Related Activities: PE 0602203F, Aerospace Propulsion. PE 0602601F, Spacecraft Technology. PE 0603218C, Research and Support. PE 0603226E, Experimental Evaluation of Major Innovative Technologies. PE 0603500F, Multi-Disciplinary Advanced	Actual	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	<u>Complete</u>	<u>Total Cost</u>	
Pro	ject 682J			R-1 Shoppi	ng List - Item No.	26-27 of 26-28				Exhibit R-2a (P	E 0603401F)	

Exhibit R-2a, F	DATE February 2005	
BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603401F Advanced Spacecraft Technology	PROJECT NUMBER AND TITLE 682J Spacecraft Vehicles
 (U) <u>C. Other Program Funding Summary (\$ in Millions)</u> Development Space Technology. This project has been coordinated through the (U) Reliance process to harmonize efforts and eliminate duplication. 		
(U) D. Acquisition Strategy Not Applicable.		
Project 682J	R-1 Shopping List - Item No. 26-28 of 26-28	Exhibit R-2a (PE 0603401F)

PE NUMBER: 0603444F PE TITLE: MAUI SPACE SURVEILLANCE SYSTEM

Exhibit R-2, RDT&E Budget Item Justification								DATE	DATE February 2005		
BUDG 03 A d	BUDGET ACTIVITY PE NUMBER AND TITLE 03 Advanced Technology Development (ATD) 0603444F MAUI SPACE SURVEILLANCE SYSTEM										
	Cost (\$ in Millions)	FY 2004	FY 2005	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010	FY 2011	Cost to	Total
	Cost (\$ in Winnons)	Actual	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Complete	
	Total Program Element (PE) Cost	50.208	58.189	5.848	6.005	6.082	6.596	6.735	6.860	Continuing	TBD
4868	Maui Space Surveillance System	50.208	58.189	5.848	6.005	6.082	6.596	6.735	6.860	Continuing	TBD
	(U) <u>A. Mission Description and Budget Item Justification</u> This program funds space situational awareness technology development and demonstration at the Maui Space Surveillance System (MSSS) in Hawaii, as well as the operation and upgrade of the facility. Note: In FY 2005, Congress added \$33.9 million for the MSSS, \$8.5 million for High Accuracy Network Determination System, and \$10.0 million for Panoramic Survey Telescope And Rapid Response System (Pan-STARRS). This program is in Budget Activity 3, Advanced Technology Development, since it enables and demonstrates technologies for existing system upgrades and/or new system developments that have military utility and address warfighter needs.										
(U)]	<u>B. Program Change Summary (\$ in N</u>	Millions)									
						<u>FY 200</u>	<u>04</u>	<u>FY 2005</u>	FY	2006	<u>FY 2007</u>
(U) l	Previous President's Budget					51.58	81	6.306		6.323	6.405
(U) (Current PBR/President's Budget					50.20	08	58.189		5.848	6.005
(U) 7	Total Adjustments					-1.3	73	51.883			
(U) (Congressional Program Reductions										
	Congressional Rescissions							-0.517			
	Congressional Increases							52.400			
1	Reprogrammings					-0.10	07				
5	SBIR/STTR Transfer					-1.20	56				
(U)	Significant Program Changes:										
	Not Applicable.										
	C. Performance Metrics										
1	Under Development.										
											_
				R-1 Shopping L	ist - Item No. 27	7-1 of 27-4				Exhibit R-2 (P	E 0603444F)
					485						